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PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

160th Session (1947–48)

Vol. 160 Part 1

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PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

Session 1947–48

Vol. 160 Part 1

PROCEEDINGS OF THE GENERAL MEETING ON 16 October 1947

Professor G. R. DE BEER, F.R.S., President,
in the Chair.

Before the confirmation of the minutes, the PRESIDENT expressed the congratulations of the Society to Mr. N. B. KINNEAR, F.L.S., on his recent appointment as Director of the British Museum (Natural History). Mr. Kinnear, who was present, replied.

The Proceedings of the Anniversary Meeting held on Saturday, 24 May 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Prof. Eric Ashby, Mr. E. B. Badcock, Dr. F. Börgesen, Dr. W. S. Bristowe, Prof. G. D. Hale Carpenter, Dr. W. E. Collinge, Mr. G. F. Humphrey, Dr. J. J. Keevil, Mr. A. F. Kindersley, Mr. A. Mayfield, Prof. F. E. Weiss, Dr. Harley Williams, the Royal Society of London, the Geological Society of London, the South African Association for the Advancement of Science, and the McGraw-Hill Book Company, New York.

The following Fellows signed the Obligation in the Roll and Charter Book, and were Admitted Fellows :—Mr. Peter Robert Bell, Mr. Maurice Bradshaw-Bond, Flt./Lieut. Alfred John Cork, D.F.M., Dr. Herbert Duerden, Dr. James Wight Fairbairn, Mr. Rex Alan Henry Graham, Dr. Joyce Mildred Lambert, the Rev. H. Santapau, S.J., Mr. Francis Thomas Walker, Dr. Kathleen Mabel White, and Dr. John Wilkinson.

The President reported the deaths of the following members :—Dr. Emily Mary Berridge, The Lady Isabel M. P. Browne and Prof. George Matthai, Fellows ; Prof. Edouard Chatton, Foreign Member.

The following communications were read and discussed :—

Dr. E. M. DELF. Utilization of Seaweeds.

Abstract.—

The utilization of seaweed has long been practised in maritime situations in many parts of the world, whether for food or agriculture (mainly local) or for various commercial purposes.

Seaweed can be obtained in quantity by harvesting from the intertidal and sublittoral regions, or by collecting the drift weed thrown up after high wind or storms. In some countries collecting has been subjected to strict local controls, but in the British Isles this question has not yet arisen. Depending on assured supplies, adequate handling, efficient processing, marketing, etc., commercial developments involve numerous problems of scientific as well as of practical interest. The paper outlined some modes of local utilization and indicates briefly the commercial products hitherto obtained.

Dr. M. Burton. Reproduction and regeneration in the sponge, *Geodia barretti*. (Discussed by the President, and Dr. J. P. Harding; Dr. Burton replied.)

Abstract.—

It has long been known that the cells of sponge tissues, after being dissociated experimentally, can form regenerative cell-masses, each of which is capable of growing into a new individual. It would appear that such dissociation, with a subsequent regeneration, occurs naturally, but to a limited degree, and is occasionally found operating as a form of vegetative reproduction.

There is another phenomenon associated with growth in sponges about which there are few recorded data, namely, that the spicules comprising the skeleton may be periodically extruded.

From a collection of very young specimens of *Geodia barretti*, it appears that the extrusion of the spicules is combined with the formation of regenerative cell-masses to give an unusual kind of bud formation. [To be printed in full in Proc. **160,** Part 2.]

PROCEEDINGS OF THE GENERAL MEETING ON 30 October 1947

Professor G. R. de Beer, F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 16 October 1947, having been circulated, were taken as read and confirmed.

The President read a letter from the Home Office, conveying the thanks of His Majesty The King for the Loyal and Dutiful Address on the engagement of Her Royal Highness The Princess Elizabeth, L.G., F.R.S., Hon. Memb. L.S.

The following was thanked for a gift made to the Library since the last Meeting :—Professor G. D. Hale Carpenter, M.B.E.

The following Fellows signed the Obligation in the Roll and Charter Book, and were Admitted Fellows :—Dr. Bertie Kennedy Blount and Mr. Francis Edwards.

The President reported the death of Sir Albert Howard, Kt., C.I.E., M.A., a Fellow of the Society.

The following communications were read and discussed :—

Rev. Professor C. E. Raven, D.D. Early records of British plants, with special reference to Thomas Lawson (1630–91). [Printed in full,

below.] (Discussed by Mr. Reginald L. Hine, F.S.A., who presented the manuscript note-book of Thomas Lawson to the Society's Library; the President, Dr. B. K. Blount and Dr. J. Ramsbottom. The President expressed to Mr. Hine the Society's appreciation of this valuable donation.)

Dr. W. S. Bristowe. Notes on the habits and prey of 20 species of British Hunting Wasps. (Discussed by the President, Professor G. D. Hale Carpenter, Mr. H. J. Burkill and Mr. W. T. Stearn; Dr. Bristowe replied.) [Printed in full, p. 12.]

The Meeting then adjourned until 11 December 1947.

THOMAS LAWSON'S NOTE-BOOK

By C. E. Raven.

A small note-book containing 165 leaves (+19 torn out), 6 inches by 3½ in size, and bound in contemporary leather, has been preserved as an heirloom by Thomas Lawson's descendants. This was given by one of them, Mr. Lawson Thompson, to Mr. R. L. Hine of Hitchin; he has generously allowed me, through the good offices of Dr. J. G. Dony, to examine it and has now presented it to the Linnean Society. Its handwriting, which has been compared with that of Lawson's holograph letter to George Fox, and its contents make its authenticity certain. It appears to have been written at various periods, with different pens and different inks; but there is no evidence of personal material later than 1677; and the reference to Ray as still at Middleton Hall cannot be later than 1676. In the description which follows I have given modern Latin names for all the plants that are easily indentifiable, but have otherwise preserved the spelling of the original.

I.

The book begins with two leaves of notes of names, places and books—jottings made at different times, the most important being 'showed to me by Dr. Morrison'—of a sponge, and 'Mr. Ray at Middleton in Hemlingford hundred'. Then follow 87 leaves devoted to a list of plants extracted from printed books and classified according to the English counties; arranged alphabetically and ending with Wales, the Isle of Man and the Isle of Anglesey. Ray, in his earliest letter to Willughby, had told how he had himself made a similar compilation from Gerard, Parkinson and others (*Corr.*, p. 1). This work by Lawson was almost certainly carried out on Ray's advice and after his example. The authorities used are Parkinson ('Park'); How's *Phytologia Britannia* ('Phy'); Merret's *Pinax* ('Mer'); Ray's *Cambridge Catalogue* ('C.C.') and *Catalogus Angliae* ('Ray' or 'Catal. Plant.'); Cole's *Adam in Eden* ('Coles'); and in addition there are a few references, purely antiquarian, to Camden's *Britannia* ('Camd'). There are one or two notes of birds: 'Otis the Bustard Newmarket Heath', under Cambridgeshire; 'Loxias the Shell-apple Mer. nomen avis' and 'Oenanthe, the Wheatear or White tailes, Fallow Smitch. Mer.', under Warwick. There are also a few notes, not derived from books, appended to the extracts and usually in a different and no doubt later ink. The first of these is the long description of the locality of *Orchis militaris* 'at Cawsham nigh Reading' which runs as follows: 'From the bridge pass to Cawsham [Caversham] church. Cross the churchyard to the west. You turn short down towards the river Thames. When within a 100 yards of the Thames turn short on the right hand, passing along on the ledge of the brow of Cawsham hill, westward. This ledge is nearer the bottom

by 2 parts than the top and is a level green walk. Both on the right hand and on the left this plant grows'. To it are appended the names 'Jo Ray and Jo Watts, who also found ye female of this' (can this mean *Orchis simia*?). Watts, who was afterwards the curator of The Apothecaries' Garden at Chelsea, where he built the first hot-houses, is also responsible for a note, 'Flos Adonis J. Watts', inserted by Lawson in a blank half-line after 'Castanea' in the Kent list, and at the bottom of the second page of Middlesex. Under Cheshire there is an unsigned note of *Gentiana pneumonanthe* 'on Red Heath in Cheshire'*: under Essex there are two mistakes, Ray's Manx record of *Brassica monensis* and a Merret record from Barnack being inserted: under Lincolnshire there are three unsigned records *Samolus valerandi*, *Althaea officinalis* and *Lysimachia nummularia* 'the way side leading from Hallbich [Holbeach] to Gedney' and *Aster tripolium* 'very plentifully at Long Sutton in the ditches by the high rode'. But it is naturally under Lancashire, Westmorland and Yorkshire that these original notes are most frequent and most interesting. They deserve full treatment.

Under Lancashire are :—

Atriplex sabulosa (?) Lawson quotes Ray's note on Parkinson's Atriplex and cites '(?) 319 Cat. pl.' (it is in fact p. 35 in 1st edition *Cat. Angl.*) and adds an unsigned locality 'Furneis [Furness] sands about Roosbeck [Roosebeck]'.

Crambe maritima 'by Joseph Sharps on the sea shore & between Aldingham and Roosbeck'.

Armeria maritima 'Close by Dunnerholme [just north of Askham and on Duddon Sands] in Furneis, by Harleside on the rock by the sea shore'.

Inula dysenterica. 'By Aldingham in Furneis.'

Senecio paludosus. 'In Hilderston [Hilderstone] Mosse by Burton.'

Crithmum maritimum. 'On Dunnerholme Rock & on Harleside Rock.'

'Crithmum spinosum pastinaca marina [*Echinophora spinosa*] nigh Roosbeck sands in Furneis.'* The name comes from Parkinson and is not in Ray *Cat. Angl.* Ray included it in his Synopsis as found by Mr. Lawson at this locality: but is evidently uncertain of its identity.

'Scilla enquire of Esq. Bellingham Courtkeeper.'

Cakile maritima. 'Roosbeck'* with reference to 'Ray Cat. Plant.'

Sisymbrium officinale. 'Rampside.'

Salsola kali. 'On Arnside sands copiose.'

'Sambucus fol. lacin. Dan Abrams.'

Parietaria officinalis 'on the mannour house and Abbey in Furneis'.

Andromeda polifolia 'in a field called Little Reed among Huckleberries nigh Maudsley Coles, and in these mosses Rays Cat. pl. (in 1688 "in Brigsteer moss not far from Kendal"')).

Atropa belladonna. 'Furneis Abbey.'

Aster tripolium. 'Isle of Waney'* (this is his regular spelling *cf.* Ray *Corr.* p. 209).

'Saponaria fl. pleno nigh Carnforth Smidy.'*

Convolvulus soldanella 'nigh Lancaster'.

Statice limonium 'on the south east ends of Harleside on the sands'.

Sedum anglicum 'in the way between Ulverstone & Pennybridge by me there found T. L. and also between Marsh graine [Marsh Grange, north of Askham-in-Furness where Thomas Lower the Quaker lived] & Dunnerholme hic mihi visum'. This seems to be the only clear mention that the book is Thomas Lawson's.

Osmunda regalis 'in Marsh graine grounds'.

N.B.—Records which I have marked * occur also in the list sent by Lawson to Ray in 1688.

Myrica gale. ' Marsh grainge copiose.'
Geranium sanguineum. ' Dunnerholm copiosissime.'
Menyanthes trifoliata. ' Marsh grainge copiose.'
Anthyllis vulneraria. ' Dunnerholm copiose.'
Helianthemum chamaecistus ' ibidem copiose '.
' Lysimachia purpurea trifolia caule hexagono [the variety with three leaves of *Lythrum salicaria*]. In the ditches about Marsh grainge, copiose.'
' Behen album Dunnerholm copiose fl. albis.'
Hydrocotyle vulgaris. ' Marshgrainge copiose.'
' Muscus filicinus by Swarthmoor.'
' Muscus marinus rubens pennatus and Muscus marinus albidus Dunnerholme.'

Under Westmorland :—

' Arbor Vitae at James Bellingham Esqre of Levens.'
Barbarea vulgaris. ' Great Strickland.'
Polygonum viviparum. ' Severall places as at Crosby Ravenswaith [Crosby Ravensworth] *, Great Strickland.'
Tamus communis ' between Kendale & Levens plentifully about Fell end '.
Carduus heterophyllus ' At my feild house by Bakestonbarth '—with a reference to Ray's *Cat. Pl.*
Hydrocotyle vulgaris. ' A little above Common holme bridge [near Cliburn] in the ditch divideing the Common & Medow.'
Polygonum convolvulus. ' Great Strickland field.'
Campanula latifolia. ' Kendale under Sherif park hedge, In my open garth.'
Sisymbrium officinale. ' Lowther behinde Cliburn Parsonage.'
Osmunda regalis. ' Kendale Dr Whitaker. Rays Cat. Plant. By Reynold Harrisons in Sledale [Sleddale].'
Antennaria dioica. ' Nuby [? Newby, near Little Strickland] pasture nigh Common holme bridge between Greenholme & Roundthwaite [near Tebay] on the Common Rays Cat Pl.' (In 1688 a different description of the place.)
Parnassia palustris. ' In my holme Limethwait Bank.'
Hedera helix. ' About Fell end in Witherslack copiose Rays Cat. pl.'
Dianthus deltoides Whinfield * (in 1688 ' a little below Common Holme Bridge ').
Lythrum salicaria ' trifolia Kendal Dr Whitaker Rays Cat. pl '.
' Mollugo montana minor Small Bastard Madder [? *Galium saxatile*]. On Kendal ffell Dr Whit [Whitaker].'
Lycopodium clavatum. ' Shap ffell.'
Oenanthe crocata nigh ' Kendal copiose Hiltondale [? Helton].* '
Polygonatum officinale ' nigh Underbarrow Chappell [west of Kendal] '.
Impatiens noli-tangere. ' Winander mear nigh Ambleside Rays Cat. pl., also in Knipes Court Barrier [?] by Kendal.' (In 1688 ' Saterthwait ' Lancs., ' many places of Westmoreland ').
Rhamnus catharticus. ' Scar about water fall bridge Sheriffe Park.' (In 1688 ' rocks and hedges by Great Strickland '.)
Galium boreale. ' Orton Winandermere Kirby Lonsdale bridge Rays Cat. pl.'
Sagina nodosa. ' Clifton Moor Great Strickland, Little Strick. pasture.'
Saxifraga hypnoides. ' Pears scar betwixt Little Strickland and Shap.' (In 1688 ' among rocks south of Sir John Lowther's Westmoreland '.)
Stachys germanica ' nigh Kendale, Dr Whitaker ' : surely a mistake.
Pyrus torminalis. ' Levens parke nigh the bridge.' *
Pyrus aria. ' Levens parke nigh the other.'
' Sanicula guttata [? *Saxifraga umbrosa*]. In Dr Whitakers garden at Kendal, Park.'

'Syringa fl. caeruleo sive Lilac . . . . in horto meo Stricklandiae' (another clear proof of the book's authorship).

Thlaspi alpestre 'on Lance Moor'.

Narthecium ossifragum 'between Shap & Kendal on both sides Hause house very nigh the same besides Winandmer water.'

Vaccinium myrtillus. 'In Whinfeild.' [? Whinfell, near Penrith.] *

Vaccinium uliginosum 'Whinfeild' *.

Vaccinium vitis-idaea 'Whinfeild' *.

Aconitum napellus 'in horto meo'.

'Anthora the wholesome helmet-flower or Counterpoyson monkshood in Dr Whitakers garden.'

'Campanula persicifolia alba . . . . at George Walkers in Kendale & Thos Warriners plentifully where roots may be had See Parkinsons Paradise.'

Orobanche maior 'in Broom closes by Skelsmoor hall [? Scales, west of Lowther] or Dodding green'.

'Pyracantha. The ever green hawthorne or prickly Corall Tree. in Tho. Sands garden in Kendale, see if it be not the same as grows in Mount Sorrill.'

Anagallis tenella 'at the foot of Sledale some 4 miles from Kendal.' * (In 1688 at the foot of Longsledale'.)

Alchemilla alpina 'on a rock towards the foot of Sledale copiose'.

'Alsine spuria pusilla repens foliis saxifragae aureae [*Sibthorpia europaea*] in Brakinthwait well nigh Brokill [Brackenhill] houses in Orton parish & in springs upon the ffair mile in the way to Sedberg'; another error of identification.

Under Yorkshire are very much fewer unsigned notes:—

Luzula sylvestris 'in the beck between Jo Blaiklings & Francis Blaiklings Sedberg'—for John Blaykling *cf. Journal of G. Fox*, I. p. 403 (Cambridge 1911).

'Regia hasta the kings speare [1] at Brignell nigh Barnard Castle.'

'Scilla between Scarborough & Burlington [? Bridlington], enquire of Tho Shipton.' [2]

Armeria maritima 'where Thlaspi fol. glob. [*T. alpestre*] grows Hinckle Haugh' *, (this is expanded in 1688 'in Bleaberry Gill under Hinckell Haugh far from the sea').

Scirpus fluitans 'nigh York found by a friend of J. Newton'—presumably the plant mentioned by Parkinson *Theat*, p. 1195 and quoted from him by Ray, *Cat. Ang.*, p. 181.

Lysimachia thyrsiflora 'nigh York by a friend of J. Newton, enquire of J. Newton for these 2'—which, if correct, is an earlier record than that by Dodsworth in Ray, *Syn.* II, p. 205. This does not seem to indicate that Newton was as yet known to Lawson: but it must mean that these notes are later than 1677, since Newton only began to botanize in 1680 (cf. *John Ray*, p. 218).

Actaea spicata. 'Among the shrubs by Malham Cove * on the lower side about the midle.'

II.

There follow seven leaves headed 'In my journey —77' [3], containing a closely written list of plants seen on the Gogmagogs and in Cambridge; in

[1] 'Hastula regia' (King's Spear) is a name applied by Turner, *Names*, [Aiij] to Asphodel or 'Whyte Affodil'.

[2] Probably son of Richard Shipton, builder of Lythe Hall, near Whitby, a place known to Lawson (cf. *Journal of G. F.*, II, p. 404).

[3] That '77' indicates the year is proved by a list inserted later (leaves 115–23) of the plants 'I observed in Westminster garden anno dom. 1677'. In the earlier list several plants are given as 'Westminster garden', one as 'Morgan's garden'; and there is a note 'Turncaps called by Edw: Morgan Martagon'. These confirm the fact that he visited Westminster during this tour, that the physic garden had not yet been moved to Chelsea and (probably) that Edward Morgan, who had been put in charge at the start of it by William How, was still there—though perhaps he had also a private garden.

Yorkshire and Lincolnshire ; in Kent and London ; Surrey and along the Thames to Maidenhead and Henley, and so through Warwickshire to his home.

These plants are as follows :—

'On Gogmagogs hills' *Campanula rotundifolia, Astragalus danicus Helianthemum chamaecistus* ('with white & yellow flowers'—a white form is still occasionally found) *, (in 1688 'on Gogmagog's Hill I gathered it with white flower') ; *Senecio campestris, Linum perenne, Onobrychis viciaefolia, Orchis ustulata, Polygala vulgaris, Anemone pulsatilla, Reseda lutea, Thymus serpyllum, Hippocrepis comosa, Ranunculus bulbosus.*

Smyrnium olusatrum ' in a close at Cambridge '.

Carum segetum ' by Cambridge '.

Cerastium arvense ' on the hill of health & by Cambridge castle '.

Carduus eriophorus, Lathyrus sylvestris, Lathyrus pratensis, Melampyrum cristatum, Tamus communis ' Madingley Wood '.

Medicago arabica ' At Barnwell by Cambridge'.

Epilobium hirsutum ' nigh Cambridge & Barnwell'.

Raphanus raphanistrum ' In Foulmire [Fowlmere] Cornfields in Cambridgeshire '.

Colchicum autumnale. ' In the closes adjoyning to Sheerburn [? Sherburn-in-Elmet] in Yorkshire.'

Scrophularia aquatica, Ranunculus scleratus *. ' By Robin Hood well nigh Wentbridge [nr. Pontefract] in Yorkshire.'

Specularia hybrida. ' In the corne by Barnsly & the moor in Nottinghamshire also in the cornfields at Retford in the same county also by St Ives.'

Hottonia palustris. ' In the high way that joins (?) Retford feilds & Barnly moor.'

Allium vineale. ' nigh Monks mill by Lincoln.'

Hippocrepis comosa. ' By St Giles at Lincoln copiose.'

There follows a list of eleven cultivated plants ' in a garden at Lincoln '.

Lithospermum arvense. ' By St Ives plentifully.'

Sium latifolium (?). ' In the waters at St Ives copiose.'

Ranunculus arvensis. ' About Cambridge plentifully.'

Anthriscus vulgaris. ' On the mud walls in & about Cambridge copiose.'

Ophrys sphegodes. ' In an old gravel pitt near Shelford by the footway from Trumpington to Shelford Church copiose, within 3 miles of Cambridge.' This is Ray's locality (*cf. C.C.* App., I, p. 7) but the details are fuller.

Dianthus deltoides and *Potentilla* (*? erecta*). ' By Deptford in Kent & in Charleton Wood there.'

Lemna trisulca, Cerastium tetrandrum. ' By Deptford.'

' Lotus quadrifolia ' *Euphorbia amygdaloides.* ' In Charleton Wood by Blackheath in Kent.'

Euphorbia helioscopia, Lysimachia nummularia, Trifolium subterraneum *. ' on Blackheath & Tuthill feilds copiose.'

Caucalis nodosa. ' By Greenwitch in Kent.'

Corydalis claviculata. ' In a ditch by Blackheath in Kent.'

Arabis glabra. ' In the lane between Charleton wood & Greenwitch in Kent.'

Rhamnus frangula. ' Charleton wood in Kent.'

Arenaria serpillifolia. ' In & about In & about [*sic*] Greenwitch in Kent.'

Arenaria trinervis. ' Charleton Wood.'

Arenaria tenuifolia, Scirpus maritimus, Hypericum pulchrum. ' About Greenwitch in Kent.'

Statice limonium, Ophrys sphegodes (?), in Kent.

Ophrys apifera ' the second species of Ray in a close adjoyning to Charleton church in Kent on the west hand ' *. (In Ray *Corr.*, p. 206, this is identified as *O. aranifera*).

Verbascum nigrum and *V. lychnitis* ' both about Deptford in Kent '.
Sonchus palustris ' nigh Greenwitch '.
Fumaria capreolata ' by Greenwitch '.
Geranium pratense ' flore albo at Kingston in Surrey '.
Veronica serpyllifolia ' in Charleton wood '.
Cerastium viscosum ' about Greenwitch '.
Malva moschata ' about Greenwitch, at Newby on the back of Rowland Wilsons ut suspicor '.
(Two mosses ' Charleton '.)

Two more pages of common plants, *Neottia nidus-avis* and *Medicago arabica* being the most interesting, are then recorded for Charleton Wood. Among them is *Sisymbrium irio* ' inter urbem et Kensington ', *Chenopodium vulvaria* ' Tuttle fields,' and several at Lewisham, Brockley or Great Brockley.

Then come several records ' in Essex ' ' nigh Hackney in Essex ', and one ' Trifolium album umbella siliquosa ' [This Ray includes *Cat. Angl.* p. 304 as from Merret, but says that he has never seen it : it is a monstrous form of *T. repens*], ' in the close betwixt Virginy House and Naghead Inne in the way to Hackney ' * : then several rushes, grasses and sedges ' nigh Pancras church by London ' : then several, including *Calluna vulgaris*, *Erica cinerea*, *Convallaria majalis* and *Cuscuta* ' found on several plants as on heath on Furze, on Bilbery plants ' and *Serratula tinctoria* ' purple & white ' ' on Hamsted Heath ' * : then several, *Scirpus triqueter* and *Triglochin* (?) ' by Thames side near Westminster ' and (a second entry) ' on Thames-side by Mill bank nigh Westminster ', *Sagittaria sagittifolia* ' nigh Westminster horse ferry ' and a number of Oraches ' found all on one dung hill by London ni fallor ' ; and then a few, including *Scutellaria minor* ' on Clapham heath in Surrey '. Among these is a paragraph describing ' Catananche ' (*Lathyrus nissolia*) ' nigh Pancras church & nigh Highgate ' and another ' on Rudheath [Rode Heath near Sandbach] in Cheshire grows a Gentianella with very small leaves 2 set directly opposite, tis undoubtedly Pneumonanthe, Calathian Violet ', which repeats the note found in his county list under Cheshire : had he only now convinced himself of the identity of this plant, or is the record a report by a friend who showed him the plant and told him where it had been found ?

A few more records from the London area follow :—
Xanthium strumarium ' at Stanes [Staines] in Middlesex '.
Galeopsis ladanum ' in the corn between Stanes & Colnbrook in Buckinghamshire copiose '.
Radiola millegrana ' on the common between Hersham & Walton in Surrey & on Ditton garth (?) in the same county '.
Sison amomum ' nigh Nonsuch in Surrey '.
Campanula rapunculus ' about Hersham in Surrey '.
' Between Maidenhead in Buckinghamshire & Henly grows ffagus, Juniperus, Laureola, Viburnum plentifully '.
' On Stanhill on the west of Hurley Wood ' grows *Linaria spuria* *, *L. elatine* *, *Carduus nutans*, *Galeopsis ladanum*, *Sherardia arvensis*.
' In Nonsuch over court ' grows *Campanula rapunculus*, Verbena, *Erigeron acre*.'

A list of many other plants follows, all apparently recorded in Nonesuch Park.

Then follow a Hieracium ' from Henly in Warwickshire [Henley in Arden] ' and White Heather ' by Sherly Street in Warwickshire ' ; and a few north-country notes.

Herniaria minima [this is not a name found in Ray's *Cat. Ang.* or *Synopsis* for whom ' Herniaria '=*H. glabra* or *ciliata* and ' Herniaria minor '=*Radiola*

millegrana, is it *Centunculus minimus* ?], ' plentifully between Gunnerthwait & Snidergill so along to Capon Wrey [Capernwray] '.

' At the same Gunnerthwait also grows *Prunella vulgaris* fl. albo, *Osmunda regalis*, *Carduus palustris* fl. albo.'

Drosera rotundifolia and *longifolia* ' in Mosey mire in Witherslack copiose ' *.

Triglochin palustre [?] frequently by Ble Crag Bridge which divides Lancashire and Westmorland on the Lancashire side the bridge. There also is *Parnassia palustris* ; *Alchemilla alpestris* plentiful in the Scar 2 bowshots south of Black Crag belonging to Banisdale head in Westmorland. Between Banisdale head & (?) Water Sleadale [Wet Sleddale] grows *Carex pulicaria* & ' Vaccinium nubis ' [probably *Rubus chamaemorus*] copiose '.

Radiola millegrana on ' Clifton moor in Westmorland.'

Ornithopus perpusillus on ' Sandforth Moor nigh The Thorn.'

After this follows a number of blank pages and then two leaves closely written with notes on religious history and biblical exegesis. Then come eight leaves dealing with the plants observed in the Westminster Garden in 1677—a long catalogue arranged according to the various paths and beds.

Then there is a page of notes partly of plants seen at ' Micham & Casalton [Mitcham and Carshalton] ' and Banstead ; partly of plants extracted from Merret and headed Isle of Wight—presumably an addendum to the classified county lists.

Then begins a long section of Church history and other theological notes, which with one page of notes on fish and turtles interpolated occupies 24 leaves. The fish notes begin ' The little cone is of a sturgeon back ' ; goes on with brief mention of flounder, mackerel, sole and whiting—the last only ' a colore '. Then follows a longer paragraph ' The dolphin pursues the flying fish which . . . . takes a flight by numbers. Then in their flight the Sea Hawk seizes on them which Sea Hawk being far from land & weary rests itselfe on the backs of the turtles which sleep much by floating on the water '. He continues : ' The little Shelfish I have of Dudsforth is called Honny Fish ' ; then gives a list of Turtles ' 1 dogges head 2 Hawks bill 3 Green, all of the Sea ' ; and finally a note on the Maid ' with a mouth & lips like a woman ', the young of the Thorn back.

After these sections of theology come more pages of plants, first a completion of the list of Westminster garden and a note on *Scutellaria minor* ' plentiful by the way side in the ditches between Horsadown & Deptford in Kent ' ; then a list ' about Cambridge ', including *Stratiotes aloides* ' above & below the great wood bridge on Audrey Caussey in the Isle of Ely, standing on the bridge & looking into the water it appears very plentifully ' ; and *Inula pulicaria* ' betwixt Haddenham & the windmill in the Isle of Ely copiose '.

Two pages later, after a few stray notes, occurs the following :—' Over against James Moors [4] shop in Kendal lives a maid that kept her father in laws shop being a dyer, who sent by Tho Cooper a Londoner to her sister at London 1[s] for a token who forgetting her name this Tho. Cooper hath given me the shilling to give to the maid of whom he received it '—a pleasant irrelevance.

Then he returns to botany with a list of nine plants in the Oxford Garden ; then ' Campanula cymbalaria folio hederaceo ' *Wahlenbergia hederaefolia* ' nigh the rows of planted willows Bagley Wood ' ; *Thesium humifusum* ' nigh Oxford ' ; *Astragalus glycyphyllus* ' nigh Oxford & nigh Stafford at the town end in the way to Stourbridge ' ; *Anagallis tenella* ' Bagley Wood nigh the planted willows ' ; *Asperula cynanchica* ' about 2 miles from Oxford west

[4] Is this the James Moore who in 1655 went with James Harrison the Kendal shoemaker into Scotland to preach ? Cf. *Journal of G. Fox*, II, pp. 326, 469.

or south west'; *Ornithopus perpusillus* 'nigh Oxford'; and then, obviously added later, five plants including *Rumex pulcher*, *Hydrocharis morsus-ranae*, in St. George's fields, and five *Veronica scutellata*, *Plantago coronopus*, *Coronopus ruellii*, *Spergularia rubra* and *Anthemis nobilis* ('Chamaemelum nudum odoratum'—the 'Chamaemelum flore nudo' of Ray's *Cat. Ang.* p. 67) in Tuthill fields. After this there are six pages of catalogue of the Oxford garden; and then after a page of other notes, there are interpolated three more pages of garden catalogue, and a few notes of wild plants; *Carduus eriophorus* 'between Abington & Oxford', *Hydrocharis morsus-ranae*, *Utricularia vulgaris*, *Potamogeton perfoliatus*, *P. densus* and *Scutellaria maior* 'in the ditch belonging to Christ Church meadow by Oxford'.

So the book gives us its last notes of his home and tour. First comes a series of plants in Dr. Whitaker's garden and elsewhere at Kendal, already listed under Westmorland; then similar notes of plants at Marsh Grange and Witherslack, also previously listed; then *Rumex hydrolapathum* and *Mentha rotundifolia* at Marsh Grange and *Scrophularia aquatica* at Witherslack and (in another ink) 'by Sawley Abby'; then *Ophrys muscifera* 'on the right hand under the wall as one goes from home park house to the yeat that opens to Home Crag * about a stones cast short of the yeat, Westmorland' (*cf.* Ray *Corr.* p. 206); *Pedicularis sylvatica* 'flore albo by Gunnerthwaite in Melling parish Lancashire' *; *Galium boreale* 'pro loco vide Ray Cat. Pl.'—*i.e.* at Orton and Windermere; *Cypripedium calceolus* in the woods by Ingleton; *Pastinaca sativa* 'nigh Sawley Abby'; *Veronica anagallis-aquatica* 'by Sawley Abby'; *Corydalis claviculata* at 'Draglabeck [Dragley Beck] by Ulverstone & at Berry nigh Manchester, so Parkinson' (this last a mysterious reference; for Parkinson *Theatrum*, p. 289 gives no British locality for this species); *Valerianella olitoria* at 'Whalley Abby garden & at Ramshaw in Bishoprick [*i.e.* Durham] so Parkinson'—another mystery; 'Populus alba altera' (is this *P. canescens*?) 'plentifully in the way between Manchester & Stopford, plentifull in Worcestershire & Gloucestershire'; 'Merry Tree in Berry or Bury in Lancashire vide Cerasus in Phy. Brit.'—this is the tree about which Ray reported Lawson's letter to him in *Synopsis*, II, p. 302; *Viola lutea* * and *Thymus serpyllum* 'nigh Eldon hole in the Peake'.

Then follow two paragraphs quite unlike any in this book. He describes in some detail the growth, leaves, flowers and seeds, of what appears to be *Ornithopus perpusillus*, first recording it as found 'in the sandy lane between Leeke & Leerbrook [? Meerbrook] in Staffordshire' and the second, a rather fuller version, 'in a plane called Saltheath between Sandon & Stafford' and also 'at Stonyford in the way as one goes from Standeford to Wulverhampton'.

Then he reverts to brief notes—some common plants between Worcester and Tewkesbury and between Tewkesbury and Gloucester, including *Blackstonia perfoliata*, *Medicago minima* (surely a mistake!) at Eastington, and *Echium vulgare* 'flore rubro' 'on a hill called Buckall hill [Buckholt] about 8 miles from Gloucester'. At Bristol his finds began with *Caucalis daucoides* and *C. nodosa*, *Asplenium adiantum-nigrum*, 'by Bristol' and 'about St Vincents rock', *Galeopsis ladanum*, *Trinia glauca*, *Viburnum lantana*, *Hypericum montanum*, *Linaria minor*, *Sherardia arvensis*, *Rubia peregrina* and *Sedum rupestre* on St. Vincent's rock or the opposite side of the river, and many others, including 'Veronica spicata recta minor [Ray's name for *Veronica spicata*] at & about Bristol: huic spica est cerulea', which must surely refer to *V. hybrida*, first recorded from this locality by Peter Turner who reported it to Jean Bauhin; and *Hippophae rhamnoides* 'at Red Cliff by Bristol, on the sea bank between Whitby & Lyth [Lythe] plentifully'. Then interpolated among further instalments of the Oxford garden plants are *Anagallis tenella* 'on the moor nigh Robin Hood bay betwixt Scarborough & Whitby',

Bupleurum rotundifolium and 'Lenticula flore albido' 'in or nigh Sailsbury plaine', *Sium latifolium* and *Lysimachia vulgaris* 'in a ditch between Abington [Abingdon] & Milton in Barkshire' and 'in the riverside by Abington', and 'Eruca Nasturtio cognata tenuifolia' (this is Gerard's name, *cf.* Johnson ed. Gerard, p. 247, for a picture of it: it seems to be *Brassica tenuifolia*) 'found in corne once nigh Sailsbury plaine'—a record which Ray accepts as unique cf. *Synopsis*, II, p. 174.

Then after two pages of itinerary come two final pages of notes, the first dealing with details of plants which he has failed to identify completely, the second with names and jottings about various friends.

It is thus not until the last pages of the book that we get the clue to the localities and the character of his journey. Then is set out for us—mile by mile—this tour round England that Lawson undertook in 1677. The record clears up the medley and uncertainties of his collecting.

He began with a visit to his former home in Furness, 'To Kendal 15 miles; To Fell end 7; to Swarthmoor 12; to Marsh Grainge 4; to Fell end 16'. Then he struck south 'to Gunnerthwaite [south-east of Burton in Kendal] 10; to Eldroth [north-west of Giggleswick] 13; to Sawley 8; to Manchester 26'. A note is inserted, 'Calling by the way at Whally Abbey [near Clitheroe] at Sir Ralph Ashtons there we saw a Sword Fish'. 'From Manchester to Castleton in the Peake land is 18 miles; to Leeke 16; to Stafford 16; to Stourbridge 18; to Worcester 15; to Gloucester 18; to Huntley [due west of Gloucester] ? 10; to Nailworth [Nailsworth] 16; to Bristol 20'. Judging by the previously given botanical notes he must have travelled this stage quickly. No doubt the Avon gorge, most famous of all plant-localities, drew him.

He proceeds 'To Bathe 10; to Amesbury rather Ambrosbury 26, nigh this is the memorable monument Stonehenge: on a river here is plenty of swans; to Shifford [Shefford] in Barkshire 19 miles; hence to Oxford (leaving the Vale of White Horse on the left hand) 16'. At Oxford the records of plants which he had kept on leaves 150–163 comes to an end. There is something of a gap between it and the list that commences with his Gogmagog plants, leaves 89–96; the next stage of the journey is barren of records. It runs: 'To Elnbery in Barkshire 10 miles; to Oxford again 10; thence to Banbury 18 miles; thence to Buckingham & Stony Stratford 19; thence by Newport Pannell [Pagnell] to Bedford 12; to Riseley [due north] 6; from Riseley by Bedford to Barton in Bedfordshire 14; to St. Albans 12; to London 20'. There follows a summary of his London outings. 'To Westminster Abby & back 8; to West. Abby againe & back 8; to Deptford in Kent & back 10; to Waltonstow [Walthamstow] in Essex & back 10; to Westminster & back againe twice 20; to Kingston upon Thames & back againe 20'. The Kentish records suggest some stay at Deptford. The summary explains the many visits to the Westminster garden.

So homewards. 'To Walton Abby in Hartfordshire, so on to Ware, Puckridge, so to Cambridge 45 miles; to Wilboram [Wilbraham] 5; to Gogmagog hills, so to Cambridge 8; thence to Over 6 miles; thence to St Ives 6 miles; thence to Haddenham in the Isle of Ely 7 miles; thence by Ely to Littleport 9; thence by Well [east of March] in Norfolk to Wisbich in the Isle of Ely [Wisbeach] 15 miles; to Dunnington [Donington] by which lives Will Dixon 20; thence by Deary hill good for milk cows & by 40 foot River to Eveden [by Sleaford] 8 miles; to Lincolne where lives Abraham Morris & Jo Mills 14 miles; to South Leverton [near Retford] in Nottinghamshire by Littlebrook ferry 11; to Balby [this must surely be Barnsley] 14; to Pomfret [Pontefract] where is Tho. English 10; to Tadcaster where is John Lefte 10; to Yorke 8'. His friends, probably fellow Quakers, become more prominent in the record as he nears his journey's end. 'To Tho. Tompsons at Molton [Malton] 12; to

Peter Hodgson [5] at Scarborough 15; by Robbin Hood Bay to Whitby 12; to Ellerby where lives Jacob Scarfe [6] 5; to Pinchinthorp [near Guisborough] in Cleiveland 11; to Horton 6; thence by Yarme & Darlington to Illnaby (?) and 3 to Heighington & Bolam to Headlam 6; to Barnard Castle 6; to Strickland 30'.

It is evident that the lists here are indepenednt of and definitely earlier than the long catalogue sent by Lawson to Ray in the spring of 1688 and printed in *Correspondence of John Ray*, pp. 192–210. Some few records marked with an asterisk are repeated in 1688, but even so, the localities are often differently described. In general the plants around Great Strickland are not the same; and in 1688 there is clear evidence of later activities—an expedition into the Lake country with James Newton when *Hymenophyllum unilaterale* was found at Buzzard rough Crag, Wrynose; a visit to Whitehaven and Cockermouth, to Ravenglass, and perhaps on the same occasion to Walney Island, which led to the discovery and distribution of *Geranium lancastriense*; and a journey to Northumberland and Newcastle-on-Tyne, to Durham, Teesdale and perhaps north Yorkshire, when he got *Potentilla fruticosa* and *Gagea lutea*. There is no evidence of further journeys to the south; and it seems clear that none had been made. That his interest was maintained and his knowledge deepened seems evident. But his travelling days were over. Probably his school at Great Strickland became more continuously engrossing. He died there in 1691 and was buried at Newby Head.

From the note-book of which the botanical sections have been here described, it seems evident that even the one journey was not primarily what Ray would have called a 'simpling voyage'. Apart from St. Vincent's Rocks and the famous places around Cambridge he did not visit any specially important localities; and his itinerary seems to have been shaped by the presence of members of the Society of Friends with whom he could stay. Nevertheless, the data here set out represent a substantial addition to early county records; and in one or two cases may well be the first notices of plants not previously found in Great Britain. His species are usually easy to identify and the localities are clearly defined. He was evidently a competent and careful botanist and it is much to be hoped that with this new material available a full-length study of his life and work may be undertaken.

NOTES ON THE HABITS AND PREY OF TWENTY SPECIES OF BRITISH HUNTING WASPS

By W. S. Bristowe, M.A., Sc.D.

(With 6 text-figures.)

The present paper contains a description of my observations on Hunting Wasps (Pompilidae, Sphecoidea, Eumenidae) during the four summers of 1943 to 1946 inclusive. My earlier observations or records have been included either in short papers (1925 *a*, 1925 *b*, 1928), or, in the case of spider-hunting wasps, in my book on spiders (1941). Some of my prey records, not included in either, were used by my friend Dr. O. W. Richards in the admirable series of papers he has published in collaboration with A. H. Hamm (1926, 1930, 1939).

I feel bound to make it clear that I am not an expert on wasps, although I watch them with eagerness on occasions, only too rare, when time is available and the weather suitable for them. I have frequently been unaware of the

[5] *Cf.* Whitby and Scarborough Register; *Journal of G. F.*, ii, p. 404.
[6] His certificate of marriage with Dorothy Lotherington is dated 1689.

names of the wasps until my observations had been completed and Dr. Richards had kindly identified my specimens. This has had certain advantages. It has added to my own excitement when I have written up my notes to compare them with what had previously been published, to see in what particulars my observations agreed or disagreed with those of other naturalists, and to find that not infrequently I have been able to add something to our knowledge of these fascinating insects.

I am indebted to Dr. Richards not only for the identification of my wasps but also for arranging with appropriate experts for the identification of the prey. I take this opportunity to convey my grateful thanks to Mr. J. E. Collin (Diptera), Mr. W. E. China (Hemiptera) and Dr. F. van Emden (Curculionid larvae).

I am responsible myself for the identification of the spiders.

The paper is arranged in two parts. Part I contains some general notes, views and conclusions based on what I have seen. In the interpretation of prey records, for instance, I suggest that a number of significant factors have been overlooked hitherto. In Part II my notes are arranged under the individual wasp species.

Part I.

A. *Notes on chain reflexes.*

The order of the principal chain reflexes of capturing prey, constructing a cell for its or their reception, and laying an egg, varies in the three Families or groups of Families with which I am concerned. The normal order for each is as follows :—

POMPILIDAE : (1) Capture of prey. (2) Cell construction. (3) Egg laid.
SPHECOIDEA : (1) Cell construction. (2) Capture of prey. (3) Egg laid.
EUMENIDAE : (1) Cell construction. (2) Egg laid. (3) Capture of prey.

Two elaborations of the normal procedure for Pompilidae are found in *Pompilus plumbeus* (F.). Having carried its prey a certain distance, the wasp buries it in a temporary shallow ' grave ', covers it with sand, and then searches for a suitable site in which to excavate a burrow. Having dug a burrow, the prey is disinterred from the ' grave ' in which it had been hidden from ants or parasites and taken inside the burrow. For some unaccountable reason the wasp then embarks on further digging operations and the actual cell into which the prey is to be placed is excavated. Is this a further protective measure against parasitism ?

Rigidity in the order of the chain reflexes can be illustrated by three examples. I have seen both *Lindenius albilabris* (F.) and *Stigmus solskyi* Mor. accidentally drop their prey at the moment of entering the burrow. Neither hesitated for a moment. Both entered their nests, stayed there the normal amount of time for storing an insect and then emerged in search of a new victim. The *Lindenius* took no notice of the discarded insect lying beside the entrance, either then or later. These are extreme cases. Not all wasps would be so unperturbed at the loss of their prey or so ' blind ' to a suitable victim away from their usual hunting-ground.

The third example is provided by *Cerceris rybyensis* (L.). Like other Sphecoidea it must dig a burrow before collecting prey. In the colony under observation I made the interesting discovery that *Cerceris* saves itself much labour by taking possession of a bee burrow (*Halictus*). This it must enlarge and adapt. *Halictus* bees of the same genus and species form the prey of this wasp but the actual owner of the purloined burrow is never used, even when it is trapped inside or stung in trying to oust the intruder. At this stage the wasp is digging. The hunting instinct is not yet free to operate.

B. *Senses employed in the capture of prey.*

Within certain limits, all the Hunting Wasps are specialists. How do they find and identify appropriate prey? Dealing with this question quite briefly, I will say that all of them use both sight and their chemotactic sense but that in one it is sight and in another the chemotactic sense which is the principal sense employed. Let us take just two examples. *Mellinus arvensis* (L.) stalks its prey like a cat and leaps on it. If the insect is too large the wasp does not stalk it. *Mellinus* clearly hunts by sight but we can suppose that if a mistake in identity occurred, the wasp's chemotactic sense would lead to rejection of the insect after contact had been made.

Pompilus plumbeus (F.) will chase and often, perhaps usually, lose a suitable victim which it happens to ' put up ' in the course of its hunting, but this is not its principal method of catching the spiders with which it stores its nests. Richards and Hamm (1939) do not mention, when summarizing the results of English and European observers, what I regard as the normal hunting methods. The wasp rushes over the sandy ground in which a spider, *Arctosa perita* (Latr.), inhabits burrows. The wasp touches the ground with its antennae as it walks. Should it come to an open *Arctosa* burrow it will rush inside and either catch the spider or else chase it, with varying success, should it succeed in escaping from an emergency exit. Very frequently the entrance to the silk-lined burrow is closed but this does not prevent the wasp finding the spider. In the midst of its headlong rush across the sand the wasp will stop, touch the ground with its antennae and then start to scratch and bite away the sand A hole is made into the spider's burrow, which was invisible to the eye, and in rushes the wasp to seize its victim. This species can thus find its prey by means of its chemotactic sense alone, although on some occasions sight, too, is used.

C. *Methods of holding the prey.*

The rich variety of habits met with amongst Hunting Wasps is exemplified by a comparison of the methods of holding and carrying their prey.

Most of the Pompilidae drag their prey by a leg. *Episyron rufipes* (L.) flies. *Pompilus plumbeus* (F.) walks with its spider held aloft by the pedicel in front of it. (Other observers have thought it was held by the base of a leg.)

Most of the other wasp families fly with their prey. The prey is almost invariably ventral side uppermost. Several wasps grip the prey near the

FIG. 1.—*Oxybelus uniglumis* with a fly impaled on its sting.

anterior extremity with their mandibles and hold them in position with their front legs. Thus *Trypoxylon figulus* (L.) grips the spider's chelicerae and palps ; *Cerceris rybyensis* (L.) grips one of the bee's antennae and supports the bee's body with its legs ; *Stigmus solskyi* Mor. grips the Psyllid at the junction of the thorax and abdomen ; *Odynerus spinipes* (L.) grips the larva behind the head and supports it with its front pair of legs ; *Mellinus arvensis* (L.) grips the fly's proboscis and supports it with its front pair of legs.

Some wasps do not grip their victims with their mandibles at all. *Harpactus tumidus* (Pz.), *Coelocrabro leucostomoides* Rich., and *C. ambiguus* (Dahlb.) clasp their prey beneath their bodies with their second pair of legs. *Crossocerus elongatulus* (v. der Lind.) clasps its prey round the thorax with *one* of the second pair of legs only.

Oxybelus uniglumis (L.) impales the fly's thorax with its sting and, with the fly's abdomen trailing behind, helps to support its weight with the hind legs. This has been noticed by earlier observers but it has not been recorded that *Lindenius albilabris* (F.) also flies with its prey impaled on its sting. Careful observation showed me that here the 'hold' is somewhat different. The tip of the wasp's abdomen is bent down and forwards like a hook. The sting is impaled in the sternum of the victim, a bug, whose head is directed towards the rear. The spurs of the wasp's second pair of legs help to support the bug's weight.

FIG. 2.—*Lindenius albilabris* with a bug impaled on its sting.

D. *Concerning the nests of Hunting Wasps.*

Under this heading I include miscellaneous observations and ideas which seem to be new.

In two respects my observations are in conflict with earlier workers. Hamm and Richards (1930) say in regard to *Trypoxylon figulus* (L.) that 'the bottom of the burrow is always lined with mud'. In more than twelve nests seen at Ranmore, Surrey, mud was always absent at the bottom.

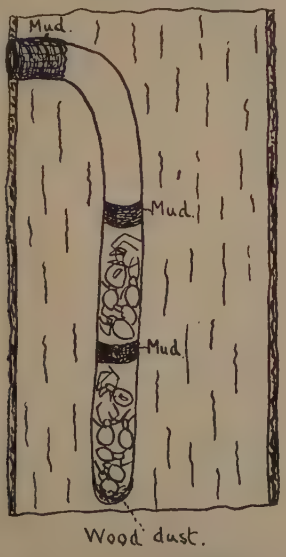

FIG. 3.—Nest of *Trypoxylon figulus* (nat. size).

Hamm and Richards (1930) report Adlerz (1903) recording in Sweden that *Harpactus tumidus* (Pz.) always closes the entrance of its burrow while away hunting. The wasp does not do this at Trebetherick, Cornwall.

In the thriving colony of *Crossocerus elongatulus* (v. der Lind.) at Welwyn,

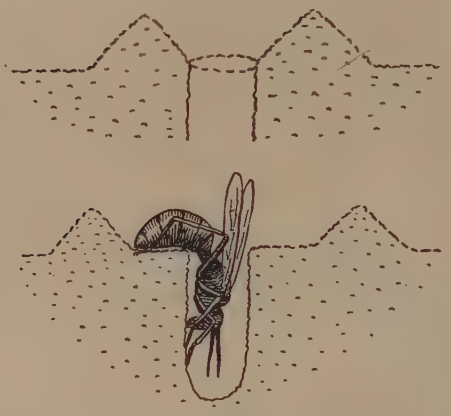

FIG. 4.—*Pompilus trivialis* prevents dry excavated sand from filling the burrow by swirling the abdomen round.

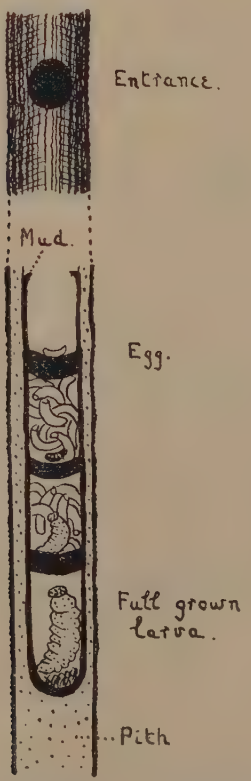

FIG. 5.—Nest of *Odynerus laevipes* showing unstalked egg (nat. size).

several wasps, sometimes four, used the same entrance. No doubt their own particular burrows branched out below the surface from the communal passage.

The digging of a burrow in loose sand is no easy matter, because of ' landslides ' which are apt to choke the entrance unless the hole is excavated in a steep bank. *Pompilus trivialis* Dahlbom kicks the earth out with its hind legs and then swirls its abdomen round the entrance. In this way a flat platform around the entrance is made instead of a steep-sided crater.

Wasps of the genus *Odynerus* (Eumenidae) are said always to lay an egg in their cells which hangs on a thread from the roof. Whatever the advantage of this thread may have been, and opinions differ on the subject, this could hardly exist in those cases where the egg is laid at the bottom of a hollow stem. *Odynerus laevipes* Shuck. nests in upright hollow stems and I found the eggs were not attached to the cell wall by any thread in the two nests I have examined.

FIG. 6.—Nest of *Odynerus spinipes* showing funnel and stalked egg (nat. size).

The earth excavated by *Odynerus spinipes* (L.) in digging a burrow in banks is brought in pellets to the surface and glued together into an attractive funnel. This may have some protective advantage, as other writers have suggested, but I have not seen the idea advanced that the funnel represents the original cell. Allied genera, such as *Eumenes*, construct neat mud cells from glued pellets of earth. They are often parasitized in spite of the mud wall. Perhaps an ancestral *Odynerus* differed only in collecting its mud from inside the site of the cell, with the inevitable result that a depression in the ground was formed in which the stored prey were placed. From a depression in the ground, a cell, to an actual burrow, or several cells, is a natural development. It can be supposed that this might well afford added protection from the weather and from some of the enemies. The mud funnel may, therefore, represent a survival from an earlier habit of making mud cells. The newer habit, if such it is, has not given permanent immunity from all parasites (as I shall show later) but some advantages may still remain.

E. *Factors which affect the prey stored by wasps in their nests.*

Hunting wasps specialize to some extent on particular prey. Thus one species will catch flies, another bugs, and another spiders. It is rare for any wasp species to spread beyond the limits of one Order but *Lindenius albilabris* (F.) is one of the exceptions in collecting both bugs and flies. Some species confine themselves, so far as is known, to a single Family; others to a single Genus.

Competition between the different species of wasp is lessened not only by their specializing on prey belonging to different Orders, Families or Genera but also by their selecting different types of terrain in which to hunt. Amongst the spider-hunting Pompilidae, for instance, *Episyron rufipes* (L.) hunts on the wing and seizes spiders in their webs, *Pompilus cinctellus* spin, hunts amongst low vegetation and catches spiders on the stems of plants, *Anoplius fuscus* (L.) searches amongst clumps of vegetation and pounces on ground-living spiders, *Pompilus plumbeus* (L.) explores the bare sand on heaths and dunes for the species which live in such situations, and *Deuteragenia hircana* (F.) hunts on walls and tree trunks for those which inhabit the chinks and crannies.

The last species, *Deuteragenia*, will enter the silk tubes of *Segestria senoculata* (F.) to seize the occupant, but it cannot negotiate the adhesive silk of cribellate spiders such as *Ciniflo*.

Specialization carried to extremes may have certain disadvantages in limiting the distribution of the wasp to that of its prey. Two such extremes include *Gorytes mystaceus* (L.) which has 'learned' to extract the nymphs of *Philaenus spumarius* (L.) from the froth of the 'Cuckoo Spit', and *Methoca ichneumonides* Latr. which has developed a specialized technique for the subjugation of the formidable Tiger Beetle larvae in their burrows.

Within the Order, Family, or Genus comprising any particular wasp's prey the required specification must take size into account. Many species will be too small and many too large. *Mellinus arvensis* (L.), for instance, will only collect flies ranging in body length and bulk from that of, say, the Lesser House Fly to that of a large Blue-bottle. Other wasps, particularly the Pompilidae which require a single victim for each larva, have a narrower range of tolerance. If we were to place a hundred victims of *Anoplius fuscus* (L.) side by side we might find up to six species of spider represented but all would be slightly less than half an inch in length, and the difference between the largest and the smallest would be barely 2 mm.

When we compare all the known prey records, we find that most wasps will store quite a variety of species as opportunity offers. The habits, both of the wasp and its prey, influence the result but *the prey which predominates is usually the commonest suitable species in that particular hunting-ground.* This was impressed upon me during an expedition to Brazil (1925). In one locality I found that *Trypoxylon albitarse* F. filled its cells exclusively with a thorny Argyopid Spider, *Micrathena bifurcata* Hahn. In another locality I found that *T. fabricator* Sm. stored nothing but silvery Argyopids of the genus *Leucage*. I might have been tempted to think that these two wasps specialized on these spiders if I had not examined their habits elsewhere. In other localities where the *Micrathena* and *Leucage* were absent or did not abound, the nests of both wasps were stocked with a variety of Argyopids of various shapes and sizes belonging to several different genera.

Let me illustrate the same thing with some of the wasps described in the present paper. I am listing 125 specimens of fly taken from *Mellinus arvensis* (L.) on sand dunes at Trebetherick. They comprise twelve species. The same wasp hunting at Oxshott Heath on dung and on tree stumps caught several flies not included in my Trebetherick list. (*Pollenia vespillo* (F.), *Musca corvina* F., *Polietes lardaria* (F.), *Sarcophaga* sp., *Anthomyia* sp.) On the seashore in the Scilly Islands I watched it catch *Fucomyia frigida* (F.), which was not in my Trebetherick or Oxshott lists, but which was the commonest species in that particular hunting-ground.

This is not merely a question of different localities. Two wasps nesting close together may have different hunting-grounds. *Mellinus arvensis* (L.) had two hunting-grounds at Trebetherick within a quarter of a mile. Many were collecting flies amongst the blossom of a Tamarisk hedge. Not far away others were hunting on the ground amongst the short turf adjoining the sand dunes. The commonest fly on the Tamarisk was *Pollenia rudis* (F.), and this comprised more than half the prey stored in their nests. *Scatophaga stercoraria* (L.) and *Helina duplicata* (Mg.) were also well represented. The wasps collecting on the ground brought in only anoccasional *Pollenia rudis* (F.), but were storing chiefly *Helina duplicata* (Mg.) and various species of *Lucilia* and *Calliphora*.

Another example was provided by the Jassid-hunting *Coelocrabro ambiguus* (Dahlb.). Several wasps occupied beetle burrows in a spruce stump, but the cells of one wasp contained nothing but *Eupteryx urticae* (F.), of another, nothing but *Eupteryx vittatus* (L.), and of a third, nothing but *Alebra albostriella* (Fall.) Some wasps were collecting a mixture of species. This clearly depended on the actual tree, shrub or clump of vegetation which each wasp had selected as its hunting-ground.

Some species of wasp have two generations in a year, so it is likely that the prey available to the two generations will be somewhat different. I have made no study of this, but I have noted a difference between the prey available to a *Lindenius albilabris* (F.) colony at the beginning and end of its hunting-season. On July 7th the wasps brought in three nymphs of *Stenotus binotatus* (F.), a female *Trigonotylus ruficornis* (Geoffr.) and a nymph of *Megaloceroea linearis* (Fuess.). Four weeks later I watched them bring in three males, two females and 16 nymphs of *Plagiognathus arbustorum* (F.).

Wondering if the time of day might have any effect on the prey available to wasps, I watched *Crossocerus elongatulus* (v. der Lind.) at work in the morning and afternoon respectively on June 24th. The morning prey comprised ten specimens of *Empis* and two *Chlorops*. The evening captures (after 6.30 p.m.) were eight *Chlorops* and one *Agromyzid*. Most of my watching had previously taken place in the evening and I had learned from this that Chloropids were the principal prey, so it came as a surprise to find more Empids than Chloropids being stored. The explanation must lie in the habits of the Empididae and Chloropidae respectively, which result in the former being more readily available in the morning and the Chloropids later in the day.

Mellinus arvensis (L.) hunts for flies in early September between 7 a.m. and 6 p.m. Its principal prey on the Tamarisk hedge, *Pollenia rudis* (F.), does not arrive in force until an hour or two after 7 a.m. and leaves before 6 p.m. At approximately 7 a.m. I found *Mellinus* with two *Scatophaga stercoraria* (L.) and four *Helina duplicata* (Mg.). Later in the day *Pollenia rudis* (F.) represented more than two-thirds of the prey being brought in. Then, at about 6 p.m., I took from the wasp one *Pollenia*, four *Scatophaga* and eight *Helina*.

Weather conditions also caused a variation in the wasp's catch. On cool sunless days there were fewer *Pollenia* on the Tamarisk. In consequence of this *Scatophaga* and *Helina* represented a higher proportion of the suitable fly population in the hunting-ground and became the principal victims.

Prey records often indicate a marked preference for male or female prey. In the light of what I have indicated above, some explanation of this is possible. *Anoplius fuscus* (L.) specializes on female spiders. It requires one bulky spider to serve as food for each larva and the variation in the size of its prey is small. The male spiders are distinctly smaller. They probably escape capture through not coming up to the requisite size.

Most of the bees captured by *Cerceris rybyensis* (L.) are females. This is explained by the wasp's method of hunting. It patrols up and down the bees'

nesting-sites and pounces on the females, usually when they are returning, laden with pollen, to their burrows. Male and female insects often have somewhat different habits and one or other of them may predominate in the hunting-field at the main hunting period.

The main purpose of the foregoing notes on wasp prey is to call attention to certain factors which have been overlooked hitherto and to provide explanations for some of the different results met with by different naturalists. A particular species of wasp may have quite a wide range of potential prey but the actual prey with which it shares its nest in any given district will depend on the relative abundance of the species of potential prey in its own particular hunting-field at the time it goes hunting.

Part II.

Pompilidae.

Pompilus plumbeus (F.)

This brisk little greyish wasp has been watched at work by several naturalists in Britain and on the Continent. Their descriptions disagree in some particulars and are incomplete in others, so my observations at Trebetherick, Cornwall, towards the end of August, 1945, provide some contribution to our knowledge.

P. plumbeus is common where there is sand. It is a very energetic hunter, rushing over the sandy patches, zig-zagging here and there, and flying to new patches of sand whenever vegetated areas are encountered.

Like Nielsen (1920) and other naturalists, I longed to see the wasp encounter a spider but I did not copy their method of dropping a suitable spider in the line of its advance. I watched in patience and had my reward. First, let me mention that the principal prey of the wasp is known to be a Lycosid, *Arctosa perita* (Latr.), which is very difficult to see in the sandy situations to which it is restricted. The spider excavates shallow burrows in the sand, the entrance to which is closed with silk and sand in dull weather. On sunny days the spider sits at the entrance or goes on expeditions in search of prey.

In the course of its rapid rush across the sand I saw a wasp pause and begin to scratch at the sand with mandibles and front legs. Circling round, it now behaved just like an excited dog in search of a rabbit; scratching here, moving there, circling round and then scratching up more sand, I soon realized that it had found the closed burrow of an *Arctosa perita* (Latr.). During its hunting expeditions the wasp moves with antennae vibrated and touching the ground in front of it so that the spider's whereabouts are detected by the wasp's chemotactic sense.

The wasp I had chosen to watch on August 22nd had no luck. The spider's burrows often pass a short distance just below the surface before twisting steeply downwards, and on no less than three occasions I saw spiders (*Arctosa perita* (Latr.)) bite their way out through another portion of the silk-lined burrow and dart away to safety. On one of these occasions the wasp was just entering by the hole it had itself cut, so the escape was not noticed. On the other two occasions a chase followed but the spiders escaped, one by running up a marram grass stem.

During the next eight days I had further opportunities to watch *Pompilus plumbeus* (F.), but by September 3rd the hunting-season had ended, despite enticing sunshine.

No doubt the wasp sometimes catches its prey in the open with the aid of eyesight and speed, but having seen several wasps at work, I came to regard the normal procedure to detect the burrow by means of the chemotactic sense and then to sting the spider below the ground. When a wasp and spider

were enclosed together in a glass tube the latter made one half-hearted lunge forward and then seemed to be stricken with paralysis before it had been stung. It lay still with legs entwined round its cephalothorax in an unnatural position whilst the wasp seemed to sting it in the sternum.

It is interesting to notice that when one disturbs an *Arctosa* with a grass stem whilst it is sitting in the entrance to its burrow, the spider immediately seizes the side flaps with its chelicerae and front legs, pulls them inwards so as almost to close the doorway, and then turns round to complete the closure with new silk. This is of no avail against *Pompilus plumbeus*, but it might prevent the entry of other intruders.

When *Pompilus plumbeus* finds an open doorway, it rushes straight in and stings the spider. When the door is closed and the burrow invisible to the eye, the wasp tears a hole in the manner already described, and darts in to find the owner. The ' inherited fear ' of Pompilid wasps by spiders, to which I have referred elsewhere (Bristowe 1941), saves the former from damage, even in the confined space of a burrow.

After a short interval the wasp emerges, hauling the spider after it. On reaching the open air the wasp seizes the spider by the pedicel (*i. e.* the narrow neck joining the abdomen to the cephalothorax) in its mandibles and walks forwards quite rapidly with its own head and thorax somewhat raised in such a manner as to keep the spider from bumping against the ground. Other authors have said that the spider is gripped by a leg, but I am confident that in the cases I saw it was the pedicel. The spider's ventral surface is towards the wasp.

After walking for a short distance the wasp drops the spider and hastily excavates a shallow pit. This takes only a few seconds. The spider is placed in the pit and sand is kicked over it until it is concealed, and the pit covered in just about level with the surrounding ground. After circling round this hiding-place the wasp rushes away to a sandy bank, a yard or more away perhaps, and starts to dig a burrow. On August 30th a burrow was dug in five minutes, but on August 28th (possibly due to heavy rain during the night) four burrows were started and rejected before the wasp completed the task. Another possible explanation would be the close attention of no less than three *Ceropales maculata* (F.), a wasp which is a parasite of *P. plumbeus*. On several occasions the *Pompilus* rushed fiercely at them and drove them away, but they always returned.

Having dug a burrow *Pompilus plumbeus* returns to the temporary grave, uncovers the spider, grips it by the pedicel and carries it towards the burrow. When within an inch of the entrance, the spider is dropped, the wasp inspects the burrow, pulls the spider to the entrance, enters, and then hauls the spider by a hind leg into the burrow.

The subsequent behaviour of the wasp puzzled me and I have since found that other observers are also in doubt as to what precisely occurs. On one occasion I could see the wasp within the burrow thirty minutes after it had disappeared with the spider, *excavating* sand from inside ! On another occasion I saw the wasp drag its prey inside a wide-mouthed burrow at 11.6 a.m. Six minutes later it was kicking sand out of the burrow. At 11.16 the wasp seemed to be pulling in the roof and sides and at 11.20 it emerged and did not return, although the burrow was not closed flush with the ground. In the evening I marked the burrow which was still not completely closed. On the following evening I dug it up and found one spider with an egg attached to its abdomen. Adlerz (1906) has suggested that the actual cell is not excavated until after the spider has been brought into the burrow, and this I believe to be the correct explanation. The failure of the wasp to fill in the burrow was probably an exceptional occurrence, due perhaps to my presence.

At Trebetherick I found this wasp with seven spiders, all of which were *Arctosa perita* (Latr.). All were immature, except one female which was larger than the wasp, but this did not prevent the latter carrying the spider raised above the ground. None of the spiders was dead. One seemed to have recovered almost completely after three days, so I released it.

Pompilus trivialis Dahlb.

This wasp is common at Trebetherick on the sandy banks and sand dunes. Like *P. plumbeus* (F.) it seems to use its chemotactic sense to find the concealed burrows of Lycosid spiders.

Three times I saw it dragging paralyzed spiders along the ground. Two were immature *Arctosa perita* (Latr.) and one an immature *Tarentula accentuata* (Latr.).

Whilst digging a burrow, occasional visits were paid to inspect the spider. When it was finished the spider was hauled by the base of a leg to within a few inches of the entrance, dropped whilst the wasp inspected the burrow, and then dragged inside. An egg is attached to the side of the abdomen.

By August 30th the hunting-season comes to an end. Thereafter the wasp rushes about as busily as ever and often digs burrows, but it has ceased catching spiders.

Episyron rufipes (L.).

This wasp hunts on the wing and specializes on Argyopid spiders. On June 17th, 1938, I saw one at Braunton Burrows sitting at the centre of an orb web holding the spider *Aranea redi* Scop., which it had just stung.

At Trebetherick I have caught these wasps flying with immature *Aranea diadema* L. twice and an immature *A. foliata* Fourcr. once between August 20th and 30th. Whilst digging burrows the wasp perched the prey on the forks of grass stems or other plants above ground level. After August 30th no further hunting took place, although the wasp dug some burrows.

Anoplius nigerrimus (Scop.).

Owing to a confusion of species Richards and Hamm (1939) can only provide one record of prey in Britain and that goes no further than the family—'Lycosidae imm.'. On September 16th, 1943, I caught this wasp dragging along a female *Trochosa terricola* Thor. on the golf course at Trebetherick.

Anoplius fuscus (L.).

This large species preys mainly on adult Lycosidae. I have myself recorded 47 Lycosid prey from Surrey heaths, comprising 40 *Trochosa terricola* Thor., 4 *Tarentula accentuata* (Latr.), 1 *T. carinata* Oliv. and 2 *Arctosa perita* (Latr.). All of these were adult females.

On April 12th, 1944, I found this wasp on Bloxworth Heath, Dorset, with two females of *Tarentula accentuata* (Latr.) and one female *Trochosa terricola* Thor.

These wasps were active at the beginning of September at Trebetherick, Cornwall, but they were merely running aimlessly about or digging burrows, at least a foot in depth, for winter hibernation.

Priocnemis perturbator (Harris).

On June 2nd I caught this wasp dragging by a leg an adult female *Trochosa terricola* (Thor.) at Ranmore, Surrey. The spider was alive but paralyzed.

Sphecoidea.

Trypoxylon figulus (L.).

The *Trypoxylon* wasps, of which we have three species in Britain, all collect spiders. They differ in habits from our only other spider hunters, the Pompilidae, in many respects, of which the most obvious is the collection of several small spiders for each larva instead of one large one.

Trypoxylon figulus (L.) has not been studied closely in this country, so I give a fairly detailed account of what I have seen. Hamm and Richards (1930) give an admirable summary of the work of continental naturalists and in a supplementary paper Richards (1944) provides some British prey records.

Early in June 1945, I saw these slender-bodied black wasps examining garden posts on Ranmore Common, Surrey. Then, in the evening of June 19th, I watched one clearing out the old burrow of a beetle larva in one of these posts. The wasp entered head first, emerged backwards after only a few seconds, flew horizontally backwards a few inches, and dropped a load of wood dust. Back it went immediately to collect a fresh load and the process was continued at this high speed over and over again.

On June 20th I sat down to watch this wasp. I give a consecutive account of what happened. Less intensive watching of other specimens confirmed that what I saw in this case was typical for the colony in my garden. Elsewhere there would, of course, be variations in the nature of the prey available, in the time taken to collect victims and the mud for sealing the nests, and in the choice of nesting-sites. At Cooden, for instance, these wasps use as nesting-sites the narrow lead-piping which drains away the moisture that collects inside steel-framed windows (Bristowe, 1941). Richards (1944) found them using old bee burrows in a perpendicular gravel face at Langley Park, Bucks.

My vigil did not start until 1.40 p.m. (Greenwich time) but subsequent examination of the nest showed that by that time this wasp had collected one spider. At 1.41 it flew to the post holding a spider in its mandibles. The spider was held by the chelicerae and palpi. The wasp alighted on the post beside the burrow, passed the spider forward into the hole with its front legs, and then entered head first. After a lapse of two minutes it backed out and flew away. The time-table of arrivals with spiders and departures was as follows :—

Arr. 1.41, dep. 1.43, arr. 1.53, dep. 1.55, arr. 2.07, dep. 2.10, arr. 2.16, dep. 2.18, arr. 2.28, dep. 2.30, arr. 2.33, dep. 2.36, arr. 2.37, dep. 2.38½, arr. 2.39½, dep. 2.43, arr. 2.46½, dep. 2.57.

This shows (1) that the wasp started hunting for prey at about 1.30, (2) that the time taken to collect a spider varied from 1 to 12 minutes, with a marked speeding up of the period towards the end as though it had discovered the best hunting-ground or otherwise gained experience, and (3) that it usually took two minutes inside the burrow to store the spider. Where it took longer, there was usually an explanation. For instance, on returning to the nest at 2.33 the wasp was closely followed by a Tachinid fly. This seemed to disturb it. It came out at 2.34, chased the fly fiercely, and then entered the burrow again, as though it were seeing that all was well, and did not leave until 2.36. Much the same thing happened at 2.39½. The wasp emerged in a quarter of a minute, chased the fly away, went in to complete its task, emerged and walked all round as though to satisfy itself that the fly had gone, re-entered the nest and flew away at 2.43.

The last visit on the time-table took 10½ minutes. In the middle of this it emerged, reversed its position and entered abdomen first. I assumed that this was to lay an egg, and perhaps to ram the spiders tightly into the cell. An egg was subsequently found on the last spider to be stored.

After leaving at 2.57 the wasp devoted the next 62 minutes to collecting

mud and closing its first cell. In the course of this time it brought in twenty-one pellets of yellowish clay in its mandibles. It took ½ to 1½ minutes to collect a mud pellet and 1½ to 2½ minutes inside the nest putting each into position. Occasionally it emerged, abdomen first as usual, and then went in abdomen first. On these occasions the tip of the abdomen was used no doubt to press and shape the partition. The concavo-convex shape of these partitions confirmed this view. Whilst at work inside the burrow the wasp vibrated its wings and produced a humming sound. After emerging it usually walked about on the post for a few seconds before flying away.

After bringing twenty-one mud pellets, the *Trypoxylon* paid four further visits to the nest between 3.59 and 4.17 but it was carrying nothing, so far as I could see. Perhaps this period gives the partition a short space in which to dry and harden. When it arrived at 4.17 it went in head first, emerged at 4.20, flew round, sunned itself on the post, returned to the nest, went in head first and then abdomen first and finally flew away at 4.22.

Six minutes later, at 4.28, it arrived with a spider, so it was obviously stocking a new cell. The time-table for arrivals with spiders and departures was as follows :—

Arr. 4.28, dep. 4.29, arr. 4.34, dep. 4.36, arr. 4.41, dep. 4.46.

When it arrived again at 4.47 it was carrying a pellet of yellow clay, so this cell was obviously being sealed up with only three spiders in it. The work was being carried out about one inch below the entrance and it took twenty-nine minutes to complete. At 5.16 it started to block the outer entrance to the burrow.

When at work on the outer entrance the wasp craned its head and thorax into the burrow whilst the abdomen was arched round so that the tip rested on the surface of the post. Vibrating wings produced a dull buzz and it rotated in a circle round the entrance. Sometimes it came out and pushed the tip of the abdomen against the mud. It was still taking ½ to 1½ minutes to collect mud, but only ½ to 1½ minutes to press it into position.

This work continued until about 6.10, when it did not return, although the mud barrier was not yet flush with the surface of the post. By this time the sun had gone behind the trees, but the wasp finished its task between 11.15 and 11.45 next morning (June 21st), by which time it was bathed in bright sunshine.

Before going further, I should mention that this *Trypoxylon* was bothered by two parasites. The Tachinid fly has already been mentioned. There was also a small green Chrysid, *Chrysis cyanea* (L.). This arrived whilst the wasp was away collecting mud for the inner cell barrier. Having touched the entrance with its antennae and detected by means of its chemotactic senses that the burrow belonged to its host, the *Chrysis* stealthily crept into it. It came out again almost immediately and re-entered abdomen first in order to lay an egg. Whilst inside the wasp returned. The Chrysid's head was near the entrance and I was able to see it closing the entrance tightly by bending its horny thorax upward. This hard chitinous surface is of great protective value, as no sting or bite can harm it. The *Trypoxylon* attacked it fiercely but without doing any damage to the parasite, which stayed quite still. Eventually the Chrysid escaped during a lull in the attacks.

On the subject of parasites, I must mention that I found two females of the Chalcid, *Melittobia acasta* (Walk.) in the cell of another specimen of *Trypoxylon*.

To resume with the story of the particular wasp I had been watching, I split open the post and made a drawing of the nest (fig. 3). The bottom cell contained 10 *Theridion redimitum* (L.), of which only one, an adult female, was

mature. The top cells comprised two immature *T. redimitum* (L.) and one adult female *Meta reticulata* (L.). The wasp's egg was attached to the side of the abdomen of the last spider to be stored in each case, but examination of other wasps' cells showed that more spiders are sometimes added after the egg has been laid.

The illustration shows the empty space above the last cell, which is typical of this genus, the greater thickness of the mud barrier closing the nest and the absence, contrary to Hamm and Richards' statement of the invariable custom, of any mud at the bottom of the nest. In all the cells I examined, the spiders in the lowest cell rested on tightly pressed-down wood dust.

Having split open the post without doing damage to the wasp's eggs or to the prey, I kept them under observation. The spiders were all alive and the *Meta* was almost able to walk. The eggs hatched in two days and the larvae appeared to be full grown about fifteen days after the eggs had been laid. They pupated on the 16th and 18th day, the one in the lower cell taking the longer time to do so.

With some difficulty I had marked this wasp with a tiny white spot on one of its wings and I found it at work on June 22nd filling another nest with spiders. It had no doubt found and cleared a burrow during the afternoon and evening of June 21st after finishing the sealing of the previous nest in the morning. The procedure followed the same pattern and the nest was stocked before the end of the day. This time it worked until 6.30 p.m. on the second cell partition and appeared to stay the night inside the burrow, closing the entrance to the nest during the morning of June 22nd.

In the lower cell of this nest there were 7 spiders, all immature females of *Theridion redimitum* (L.), with an egg attached to the side of the last but one spider to be stored. The upper cell also contained 7 spiders, of which five were immature females and one an adult male of *T. redimitum*, the seventh being a mature female of *Theridion notatum* (L.). In this cell the egg was attached to the last spider.

I saw no more of this wasp, although it no doubt stocked further nests. Between the evening of June 19th and the morning of June 22nd it had found, cleared, stocked and sealed two nests, each comprising two cells and containing a total of 27 spiders. The weather had been fine and sunny and on such days the stocking of the cells was completed in one day.

Some of the completed nests I opened contained only one cell.

Trypoxylon wasps were still collecting spiders during the first week in July but I did not watch them after this date.

Between June 20th and July 7th I took the following 98 spiders from the nests of *T. figulus* L. :—

> 93 *Theridion redimitum* (L.) (of which 7 were adult males, 14 adult females and the remainder immature) ; 3 *Theridion notatum* (L.) (adult females) ; 1 *Theridion tinctum* Walck. (adult female) ; 1 *Meta reticulata* (L.) (adult female).

The numbers in completed cases ranged from three to ten spiders, with six to eight as the usual number.

Trypoxylon figulus (L.) hunts amongst vegetation, so it may occasionally seize a hunting spider, but its normal prey comprises web-building spiders of suitable size belonging to the families Theridiidae, Argyopidae and Linyphiidae. The size of the wasps themselves varies considerably (see de Beaumont, 1945). At Ranmore the predominant prey was *Theridion redimitum*. In other localities it has proved to be Argyopids. The selection depends on the predominance of any particular web-building species of suitable size in each wasp's hunting-ground.

Mellinus arvensis (L.).

The habits of this common Mellinid were ably summarized by Hamm and Richards in 1930. Hobby has provided additional information (1931, 1932). My observations have been made chiefly at Trebetherick, Cornwall, in late August and early September. Here the wasps frequent sandy ground on the golf course.

The burrows are deep, so the excavated sand forms a substantial turret round the entrance, except where they are dug into the side of a steep bank. Early in the morning on fine days the wasp sits with its head showing for a time and then emerges. A few short trial flights may be made and then it flies away to the hunting-ground. In early September they start hunting by 7 a.m. (Greenwich time). One of the principal hunting-grounds at Trebetherick is amongst Tamarisk blooms. Here many flies feed and the wasps can be seen pouncing on their victims after stalking them like cats along the twigs. With their short antennae stretched stiffly forwards and their wings folded over their backs, they move closer and closer, slowly and smoothly, until a final spring is made from a distance of a half to one inch. The front legs seize the fly's body and the mandibles grip the fly's wing. The wasp's abdomen is then bent round to sting the fly in the thorax near its junction with the abdomen. Again and again it stings until the fly's shrill buzz ceases and the struggles subside. Often the fly is killed at once but sometimes a faint movement of the proboscis or ovipositor is noticeable twenty-four hours later.

Sometimes the wasps were seen chewing the head of a freshly captured fly, sucking the juices, and then allowing the fly to fall to the ground. This, however, is exceptional and the normal procedure is for the wasp to grip the fly's proboscis in its mandibles before flying to the burrow with the fly's ventral surface pressed firmly against its own by the tibial spurs of its first two pairs of legs.

On one occasion I saw two wasps stalking the same fly. Both sprang simultaneously and a tug-of-war ensued which ended in victory for the one which first gripped the proboscis.

Flying straight towards its burrow the wasp alights close beside it and walks with the fly beneath its body until within an inch or two of the entrance. Here it clambers off the fly without loosing its grip of the proboscis, turns round and walks backwards into the burrow dragging the fly by its proboscis. When the burrow is in a steep bank of loose sand this sometimes gives rise to considerable difficulty.

After about half a minute the wasp emerges and flies straight back to the hunting-ground.

Sense of direction is so good that the purloining of a burrow by another wasp cannot be due to a mistake. One morning I watched a wasp laden with a fly making repeated attempts to oust an occupier from its burrow. It made three attempts whilst still carrying the fly, and three after discarding it, but all were in vain. After this I saw it no more. Whether the occupier was merely seeking shelter or had taken possession in order to store its own prey I was unable to discover.

Mellinus is a hard worker. Having started to hunt before 7 a.m. (Greenwich time), some were still returning with flies when dusk was approaching at 6 p.m. I noticed that one which had started to excavate a new burrow after 3 p.m. must have worked after dark, to judge by the hill of sand surrounding its entrance at 7 a.m. next morning.

When digging, this wasp scrapes together pellets of sand in its mandibles and passes them backwards with the first pair of legs to the second and from the second to the third. The third pair pushes the pellets out behind it and the abdomen then pushes them away from the entrance or, when working below ground level, up the burrow and out of it.

The burrows descend in a gentle curve at first and then almost vertically. Those I excavated were twelve to fifteen inches in length. Lateral branches from the lower end, each terminating in a cell for the storage of flies, are dug as the need for a new cell arises. These lateral branches may be two or three inches in length. I have found up to seven branches and, as each completed cell contains four to seven flies, the wasp may bring about 40 flies to its burrow. If, as I suspect, each wasp excavates one burrow only, this number of flies represents the total catch.

The flies are packed tightly together with their heads pointing towards the entrance. The wasp pulls them into the burrow head first, so on reaching the cell it must turn them round in order to place them in their final resting position. Before closing each cell with sand one egg is laid. This is placed obliquely across the sternum of one of the last flies to be stored.

Male wasps hover round the burrows and occasionally enter them. Much of their energy seems to be profitless. They stalk and spring on one another. They also molest the females and I have seen a struggling mass of five wasps, four of which were males, rolling over and over down a bank without becoming separated. When a male succeeds in mounting a female's back he grips her with his legs and tibial spurs, facing in the same direction as the female, then he edges backwards, tapping her abdomen with his own, until in a position to mate.

Hamm and Richards (1930) give a long list of prey. My list from Trebetherick comprised 125 specimens, which are arranged below by species in the order of their abundance :

Pollenia rudis (F.)	23 ♀, 34 ♂
Scatophaga stercoraria (L.)	18 ♀, 9 ♂
Helina duplicata Mg.	15 ♀, 5 ♂
Calliphora erythrocephala Mg.	4 ♀, 3 ♂
Lucilia caesar (L.)	3 ♀, 1 ♂
Syrphus luniger Mg.	2 ♀
Melinda caerulea Mg.	1 ♀, 1 ♂
Onesia sp.	1 ♀, 1 ♂
Chortophila cilicrura Rdi. (*florilega* of Karl).	1 ♂
Melanostoma mellinum (L.)	1 ♂
Lucilia sericata (Mg.)	1 ♀
Hydrotaea sp.	1 ♀
Total	69 ♀, 56 ♂

Harpactus tumidus (Pz.).

This species is rather uncommon in England. Burrows dug in sand are stocked with Homopterous bugs. According to continental observers, five to six leaf-hoppers are stored in each cell (Bouwman, 1927) and the burrows are closed with sand while the wasp is away hunting (Adlerz, 1903). This last point was not true of the wasp whose habits I describe below.

The only records of prey in England are of the larvae of *Philaenus spumarius* (L.) (Perkins, 1923) and of a female *Acocephalus nervosus* (Schrk.) (Hamm and Richards, 1930). Both records were from Devonshire.

On August 29th, 1945, I saw *Harpactus* walking on the sand dunes at Trebetherick, Cornwall, with a leaf-hopper held beneath its body by both the wasp's middle legs. As the wasp seemed about to fly, I caught it.

Later, I saw another wasp, laden in the same manner, alight on a blade of grass and clamber down to its base. This wasp I also caught.

On the following day I saw a third specimen walking with a leaf-hopper. Presently it rose into the air with its burden and alighted beside a hole in a

sandy bank. Without reconnaissance the wasp entered the hole and emerged head first 1½ minutes later. After a lapse of 10 minutes the wasp returned with another leaf-hopper and entered the hole as before. On digging up the nest the partially filled cell contained three leaf-hoppers.

The five leaf-hoppers taken from *Harpactus* all belonged to the same species, *Aphrodes bicinctus* (Schrk.).

Cerceris rybyensis (L.).

I associate this yellow and black wasp with stony gravel paths, because that is where I have watched it at work in gardens both in Surrey and Hertfordshire. A watcher's movements are apt to disturb it and to cause it to view him with care, tilting its head from side to side and perhaps flying away. It shows none of the jerky excitable movements of a Pompilid but flies in a leisurely fashion and does not flutter its wings or antennae when on the ground. *Cerceris* needs sun to tempt it into activity. Even then its working hours above the ground are comparatively short, since it does not emerge from its burrow before 9.30 a.m. and has retired before 5 p.m. (Greenwich time).

My observations confirm, for the most part, those of P. Marchal in France. These differ in several particulars from the earlier descriptions of J. H. Fabre. The purloining of bees' burrows, which I have watched on several occasions, seems to be the normal procedure, though this has not been recognized hitherto.

The season at Welwyn starts in the second half of July and ends before the close of August. During this time *Cerceris* seems to construct only one burrow from which lateral cells are excavated as the need arises. These are grouped near the lower end. By the end of the hunting-season there may be six or seven of them. The prey comprises solitary bees and six to eight may be stored in each cell before it is sealed with earth. During the season each wasp may therefore catch about fifty bees.

The burrows are vertical for an inch or two and curve away until sometimes they are almost horizontal. They are up to six inches in length.

When freshly completed the entrance, though open, is surrounded by a miniature ' mole-hill ', but this may in succession get washed or blown away and renewed every time a new lateral cell is excavated.

After a period of rain, July 28th (1945), was a fine day and I saw a *Cerceris* alight beside a bee's burrow (*Halictus laevigatus* (Kby.)), from which the owner was peering. The wasp started to squeeze itself down the burrow and then to bite away the earth, which it passed back with its legs and pushed with its abdomen. This enlargement of the burrow continued. Eventually I dug up the nest and found both wasp and bee unharmed.

Later in the day I saw two other freshly constructed mounds with a dead *Halictus* lying on the ground beside them.

During the next few days I watched several *Halictus* arrive home after a *Cerceris* had taken possession of their burrows. They entered and emerged several times and then in most cases flew away and were not seen again. In one instance, perhaps through attacking the wasp, one bee was stung, and I watched it struggling to the surface. It could neither fly nor walk properly. It fell on its back, tumbled over and rolled down the burrow again. Next morning it was again outside the burrow, evicted perhaps by the wasp, lying on its back and only capable of very feeble movements with its legs.

It is interesting that although *Halictus laevigatus* (Kby.) is one of the wasp's special prey, the *Cerceris* is too intent on one job at a time to capture it at this stage. First the burrow must be completed, then the prey must be hunted, and in a special way above the ground. The wasp's instinct does not allow the order or the method to be changed. Whether it eats the bee's honey, I cannot say, but I have never found any sign of the bee's cells when I have excavated the wasp's nest.

The wasp's digging operations are interrupted at intervals and it flies away to refresh itself. Then, when the first cell is dug, it goes in search of bees. The *Cerceris* females can be seen patrolling with effortless flight the paths and open ground where the solitary bees construct their burrows. Only once have I seen a capture and in that case it pounced down on a bee flying beneath it. Together they fell to the ground with the wasp uppermost gripping the bee's neck with its mandibles. Round curled the wasp's abdomen, and the bee was stung in the thorax. Some chewing of the thorax followed (malaxation) and the wasp seemed to lap up some of the bee's juices, although no serious wound was apparent. In fact I have found that the bees are not dead when they are stored and may be capable of feeble movement for one or two days after capture.

Presently the wasp flies with the bee to its burrow. One antenna is held in the wasp's mandibles (sometimes both), and the bee, ventral side uppermost, is held by the wasp's legs close to its underside. *Cerceris* then flies straight to its burrow and enters without any hesitation. I see from my notes that on one occasion I watched the wasp drop its load in order to scrape away some earth which had blocked the entrance, enter and then return to drag in the bee. According to Marchal's extensive experiments the wasp's instincts are so rigid that once the prey has been dropped to remove obstructions it is always abandoned.

The species of bee captured by *Cerceris* at Stoke d'Abernon, Surrey, were *Andrena gwynana* K., *Halictus calceatus* (Scop.), *H. leucopus* (Kby.), *H. malachurus* (Kby.) and *H. zonulus* Sm. (1928).

At Welwyn my records during 1944–46 were as follows :—

Halictus calceatus (Scop.)	2 ♀
,, *fulvicornis* (Kby.).....	2 ♀
,, *albipes* (F.)	6 ♀
,, *laevigatus* (Kby.).....	7 ♀, 4 ♂
,, *rubicundus* (Chr.)	4 ♀
,, *leucozonius* (Schr.)	1 ♀
,, *4–notatus* (Kby.)...	1 ♀
,, *pauperatus* Br.	1 ♀
,, *leucopus* (Kby.)	1 ♀
,, *tumulorum* L.	3 ♀
Sphecodes gibbus (L.).....	1 ♀
,, *crassus* Thoms.	1 ♀
Total	30 ♀, 4 ♂

Oxybelus uniglumis (L.).

A fortnight at Trebetherick during the second half of August, 1946, was so sunless and so wet that there were only two days on which wasps were really active. This is worth mentioning because for many wasps two weeks represent a quarter to a third of their hunting-season, so the effect of bad weather during a particular wasp's hunting season is likely to result in fewer being bred for the next generation. *Oxybelus uniglumis* (L.) is supposed to have two generations each summer, of which those hunting in August are the second.

On August 20th I saw five specimens of *Oxybelus uniglumis* (L.) bringing flies to holes situated within a square foot of sloping sand-bank. The flies projected a considerable distance behind the wasp and I had difficulty, on account of the shyness of the wasps, in determining how they were held. Patience and repeated observation enabled me to confirm the observations

of earlier naturalists that they were impaled on the wasp's sting and also held during flight by the hind pair of legs. The sting was fixed in the thorax of the fly. The fly was carried ventral side uppermost with the head of the fly near the tip of the wasp's abdomen.

The wasp alighted with its victim one to two feet away from the nest and then, after a short pause, flew straight to the entrance, which it uncovered and entered. It usually emerged head first after about a quarter of a minute and quickly scraped sand over the entrance before flying away. Its sense of direction is remarkable, as on returning to the right spot it has no exact landmark such as an open hole to guide it.

The females patrol the sand-banks at a height of two or three inches and pounce on their prey on the ground or in the air.

The burrows turned sharply downwards after the first half inch and were three inches or more in length. Short lateral passages led from the main burrow near its termination in a more or less horizontal direction to several cells. The average number of flies stored in each cell was six. Three flies were stored with their heads directed towards the entrance and the egg, one to each cell, was fixed to the throat of the last fly to be stored.

Hamm and Richards (1930) summarize the literature and give a list of prey records. Mine, compromising 61 specimens, are listed below:

Tachinidae:	*Sarcophaga nigriventris* Mg.	3 ♂
Muscidae:	*Helina duplicata* (Mg.)	50 ♂
	Melinia pullula (Zett.)	7 ♂
Anthomyinae:	1 damaged ♂	

Solenius larvatus (Wesm.).

This wasp lives on Ranmore Common, and I found it storing a Cyrtid fly, *Oncodes gibbosus* (L.), in an Elder stem growing in a wood clearing on July 22nd, 1945

Though not restricted to Cyrtid flies it is interesting to note that there is a marked tendency for this wasp to collect them in localities where these unusual flies are found.

Coelocrabro leucostomoides Rich. (=*leucostomus* auct.).

During the first week in June, 1945, I saw this small black wasp with silver facings enter a beetle hole in a dead cherry-tree at Ranmore, Surrey, clasping a fly beneath it with the second pair of legs.

On June 9th I found that the same wasp was using beetle burrows in old spruce stumps and in hazel posts in my garden. The wood was by no means rotten and had to be split with a wedge.

The nest comprised a simple burrow about four inches in length divided, as a rule, into four cells when storage of prey was complete. In one nest the cells contained 10, 11, 9 and 12 flies respectively. They were pressed together and tightly packed in with wood dust, a thick layer of which also served to separate the cells.

In each case the egg seemed to be attached to a fly near the bottom of the cell. The presence of pupae and larvae in an advanced stage in some nests suggested that the hunting-season may have started about the middle of May. By the middle of June the wasps had vanished and did not reappear in July. I was away in August and did not search in September. Since Hamm and Richards (1926) record it hunting prey in early June, late July, August and September, it would seem that there are two generations each summer.

The prey of this wasp varies considerably in size and also in the species of fly accepted, as the following 80 records show :—

Trypetidae :	*Philophylla heraclei* (L.)	1 ♀	
Dolichopodidae :	*Sciapus platypterus* (F.)		1 ♂
	Chrysotus neglectus (Wied.)		14 ♂
	,, *blepharosceles* Kow.	4 ♀,	6 ♂
Tachinidae :	*Pollenia rudis* (F.)	1 ♀	
Empididae :	*Rhamphomyia tarsata* Mg.	1 ♀	
	Hilara galactoptera Strobl		1 ♂
	Oedalea holmgreni Zett.	2 ♀	
	Empis sp.	1 ♀	
	Tachydromia sp.		1 ♂
	,, *pallidiventris* (Mg.)	1 ♀,	1 ♂
	,, *verralli* (Coll.)	1 ♀,	1 ♂
Stratiomyiidae :	*Microchrysa polita* (L.)		1 ♂
	,, *flavicornis* (Mg.)		1 ♂
	Beris chalybeata (Forst.)	8 ♀,	3 ♂
Muscidae :	*Coenosia tricolor* (Zett.)	3 ♀	
	,, sp.	2 ♀,	2 ♂
	Chortophila sp.		1 ♂
	Mydaea ancilla (Mg.)		1 ♂
	Fannia sociella (Zett.)	1 ♀,	7 ♂
	,, *similis* (Stein)		1 ♂
	,, spp. (3)		6 ♂
	Hydrotaea irritans (Fall.)	1 ♀	
	Muscid indet.	1 ♀	
Milichiidae :	*Phyllomyza* sp.	1 ♀	
Pipunculidae :	*Pipunculus flavipes* (Mg.)	1 ♀	
Sepsidae :	*Sepsis* sp.	1 ♀	
Agromyzidae :	*Phytomyza ranunculi* var. *albipes* Mg.		1 ♂
	Total	31 ♀,	49 ♂

Coelocrabro ambiguus (Dahlb.).

At intervals between July 8th and 14th I watched this small black wasp at Ranmore storing its nest with leaf-hoppers (Jassidae). Several of them had occupied beetle holes in the side of a spruce stump one or two inches above ground level. Inside the outer ' crust ' the wood was very soft.

The leaf-hoppers were clasped ventral side uppermost by the wasp's second pair of legs against its own abdomen. The *Coelocrabro* flies in narrowing zig-zags straight to its own hole and enters it without any pause.

The burrows were two and a half to three inches in length. The first inch or more was nearly horizontal. It then bent steeply downwards and, thereafter, soon divided into three branches, each terminating in a cell. This seemed to be the normal number of cells for a completed nest, although I found five in one instance.

During the time I was watching these wasps they took 1 to 6 minutes to return with their prey and spent 1 to 2 minutes inside the burrow each time a bug was stored. Hunting stopped at about 5.30 p.m. (Greenwich time).

Completed cells contained 13 to 22 leaf-hoppers, the usual number seeming to be about 16. The egg is laid projecting laterally at an angle from one side of the victim's throat. The prey were all stored with their heads pointing towards the end of the cell. They all seemed to be capable of slight movement with their legs in freshly stored cells. The nest comprising five cells had one

cell incomplete, three with larvae at various stages of development, and one with a pupa. When a cell is fully stocked, it is closed with about half an inch of tightly rammed wood dust.

Hamm and Richards (1926) record 569 specimens of prey, most of which are the same as, or species and genera related to, the 159 which I list below from Ranmore Common, Surrey. I noticed a marked tendency for a single cell to contain nothing but one species, although even the same wasp might have stored a mixture of species, or all of another species in the next cell. It must be supposed that this was not due to any deliberate selection but to variation in the hunting-ground.

Hamm and Richards noticed that many of their Typhlocybid prey from Oxford and the New Forest had been parasitized before capture, and Richards found that three of the eight *Typhlocybae* amongst my specimens were likewise parasitized by the Hymenopterous genus *Aphelinus* (Dryinidae).

The prey from Ranmore Common was as follows :—

Eupteryx auratus (L.)	6 ♀, 1 ♂
,, *urticae* (F.)	29 ♀, 1 ♂
,, *vittatus* (L.)	56 ♀, 3 ♂
Typhlocyba sp.	6 ♀, 2 ♂
Dikraneura mollicula (Boh.)	4 ♀,
Alebra albostriella (Fall.)	12 ♀, 39 ♂
Total	113 ♀, 46 ♂

Crossocerus elongatulus (v. de Lind.).

Little seems to be known about the habits of this wasp (A. H. Hamm and O. W. Richards, 1926). Three specimens of fly have been taken from it in Britain and more extensive records on the Continent confirm that flies belonging to many species serve as prey. It is said to nest in sand and also in old posts.

Like many another eighteenth-century mansion, Digswell Park (Welwyn, Herts) has a paved loggia with a southern aspect. Whilst sitting there in a deck-chair in June, 1943, I noticed that several of these small slim black wasps were approaching holes excavated in the crevices between the paving-stones. The notes which follow were amassed during the four summers of 1943 to 1946.

The hunting-season seems to last from about the end of the first week in June until the last week in July, but I have seen them bringing in prey as early as May 27th and as late as the first week in August in different years. Their choice of nesting-site made it impossible for me to excavate their burrows, but one point of special interest was to find that they often shared the same entrance, sometimes as many as four wasps using the same hole. No doubt the common entrance branched into separate galleries below the paving-stones, but it is rare to find solitary wasps sharing an entrance, and here it seemed to be the usual state of affairs *. No hostility was shown when two wasps arrived with their prey simultaneously.

A laden *Crossocerus* approaches its nest with a wavering flight, lands beside the entrance and goes straight in. If the entrance is blocked with a stone or a twig the wasp still zig-zags to the right spot and tries to crawl underneath or to clear the obstruction without loosing its hold on the fly.

The flies which serve as prey are much smaller than the wasp. They are usually dead but sometimes they are capable of making feeble movements with the proboscis for a few hours after capture. They are held ventral side

* Recorded previously in the case of the two other Crabronids, *Blepharipus leucostomus* (L.) and *Metacrabro quadricinctus* (F.).

uppermost beneath the wasp's abdomen, slightly aslant, by one of the wasp's second pair of legs. The fly's head is directed forwards and the wasp's leg embraces the fly's 'neck'.

The male wasps fly about near the nesting-sites and occasionally enter the burrows.

It is not always easy to be sure of the timing because two or more wasps may be sharing the same entrance, but they usually seem to stay two to five minutes inside the burrow after arriving with a fly. They emerge head first, fly straight away and return with another victim in from four to fifteen minutes. I believe their hunting-ground to be from fifty to eighty yards away across a lawn.

On fine days at midsummer the wasps are still working up till about 7.15 p.m. (Greenwich time).

No parasites seem to disturb the wasps in this site.

The prey were taken from the wasps. They provide certain points of interest. All were Diptera belonging to five different families. Continental records by Ferton include flies of several other families, so the inference is that these wasps catch small flies of suitable size common in their hunting-grounds regardless of the species or family to which they belong. This should lead us to expect a wide difference in the prey they collect in different localities and on different dates.

Of all the prey I collected from these wasps, 80 per cent. were males. The explanation of this is obscure but it must be presumed to be due to a difference in the habits of the two sexes.

The only three specimens of *Sciara* were all caught on one day in the evening of June 19th, 1943, and then no further *Sciara* were collected.

The full list of prey in the years 1943 to 1946 was:

Mycetophilidae :	*Sciara* sp.	3 ♀
Empididae :	*Empis aestiva* Lw.	3 ♀, 6 ♂
	,, *albinervis* Mg.	8 ♀, 8 ♂
	Tachydromia pallidiventris (Mg.)	1 ♀
Chrysotidae :	*Chrysotus laesus* (Wied.)	2 ♂
	,, *blepharosceles* Kow.	4 ♂
Chloropidae :	*Dicraeus vagans* (Mg.)	1 ♂
	Chlorops calceata Mg.	4 ♀, 54 ♂
	Chloropisca notata (Mg.)	1 ♂
	,, *circumdata* (Mg.)	1 ♂
	Tropidoscinis gallarum Duda	1 ♂
	Oscinella frit (L.)	1 ♀
Agromyzidae :	*Phytomyza* sp.	1 ♂
	Melanagromyza aeneiventris (Fall.)	1 ♂
	Liriomyza sp. (*pusilla* group)	1 ♂
	Total	20 ♀, 81 ♂

Crossocerus anxius (Wesm.).

These little fly-catching wasps were seen arriving with prey on July 1st and 6th, 1946. They entered burrows in a sandy roadside bank near Ardingly, Sussex. The flies were carried in the manner described for *C. elongatulus*. In one timed instance, nine minutes elapsed between leaving the burrow and returning with a fly. Fine weather on July 20th decided me to examine

their habits more closely and to excavate their nests, but by this date their season seemed to have ended. There was no sign of them.

The five flies I had taken from the wasps on July 1st and 6th were all male Empididae of the genus *Tachydromia*. One was *T. verralli* (Collin). The other four belonged to some other species not identifiable owing to damage in transit.

Twenty prey have previously been recorded in Britain (Hamm and Richards, 1926 ; Richards, 1944) and in every case the flies belonged to the genus *Tachydromia* (*T. verralli* (Collin) and *T. claranda* (Collin)).

Lindenius albilabris (F.).

Paths between Welwyn North Station and Digswell Park harbour many solitary bees and two species of solitary wasp, the present species and *Cerceris rybyensis* (L.).

The normal hunting-season for *Lindenius* lasts from the second week in June until the end of July. The burrow, about three to four inches in length, starts in a vertical direction, descends less steeply and then more steeply again to a more or less horizontal cell. There may be more than one cell to each burrow, but of this I remained uncertain because of the difficulty of excavating a stony path and the close proximity of several burrows. The earth which the wasp brings up to the surface is heaved up into a miniature molehill, but the entrance in the centre of this is left open when it is completed, except when it is accidentally closed by rain or the trampling of feet.

The wasp flies with its prey and enters without preliminary reconnaissance. Both the nature of the prey and the wasp's method of carrying it provide points of special interest.

Close relations, such as *Lindenius panzeri* (v. de Lind.), capture flies. *L. albilabris* (F.) has more or less departed from this custom and catches plant bugs, but a few flies may also be included. These flies were mainly Chloropidae, which are said to form the principal prey of *L. panzeri*.

The wasps fly with their prey beneath their abdomens and projecting slightly behind them, but as they did not seem to grasp the bugs either with their mandibles or with their legs I was considerably puzzled until I had succeeded in catching them in glass-topped boxes. To my surprise I then saw that the tip of the wasp's abdomen is bent round and forwards like a hook and that the sting is imbedded in the bug's ventral surface in the region of the sternum, perhaps between the sternum and the base of a leg. Though unrecorded for *Lindenius*, a similar method has been noticed in the American *Paranothyreus cingulatis* Pack. by P. and N. Rau (1918). In Britain *Oxybelus uniglumis* (L.) also impales prey on its sting, but in this case the insect is trailed behind instead of being pressed forward against the ventral surface of the wasp's abdomen. The spurs on the second pair of legs of *Lindenius* help to hold the bug in position.

One peculiarity of *Lindenius* is the frequency with which one finds its prey discarded at the mouth of its burrow. This is mentioned by Hamm and Richards (1926), who suppose that it is due to the wasp being disturbed at the moment of arrival. A more likely explanation is that the prey becomes accidentally detached as the wasp starts to squeeze into the burrow and that its inflexible instinct does not cater for such an occurrence.

The prey are often capable of faint movement when first brought to the nest, but they seem to die within a day or two.

The cells contain six to fifteen bugs (or bugs and flies), with nine or ten the average of eleven cells I have excavated. One egg is laid in each cell when it is full or nearly full. This is attached to the throat of the last bug, or one of the last bugs, to be stored.

Prey comprised the following 97 plant bugs and 13 flies (Chloropidae and Empididae) :—

Heterocera :	*Capsus meriopterus* (Scop.)	1 ♀,	4 ♂,	1 nymph
	Plagiognathus arbustorum (F.)	21 ♀,	14 ♂	
	,, *chrysanthemi* (Wolff.)	5 ♀,	3 ♂,	2 nymphss
	Stenotus binotatus (F.)	3 ♀,	8 ♂,	10 nymph
	Trigonotylus ruficornis (Geoffr. in Fourcr.)	4 ♀,	3 ♂	
	Megaloceroea linearis (Fuess.)			1 nymph
	Pithanus maerkeli (H. S.)	3 ♀		
	Orthotylus sp.		1 ♂	
	Amblytylus affinis Fieb.	5 ♀,	2 ♂,	5 nymphs
	Lygus pabulinus (L.)		1 ♂	
Diptera :	*Meromyza variegata* Mg.	4 ♀,	2 ♂	
	,, *saltatrix* (L.)	3 ♀,	1 ♂	
	Empis albinervis Mg.	1 ♀,	1 ♂	
	,, *aestiva* Loew	1 ♀		
	Total	51 ♀,	40 ♂,	19 nymphs

Stigmus solskyi Mor.

At 5.39 p.m. (Greenwich time) on June 23rd, 1945, I saw this tiny wasp enter a beetle hole in an Ash post, so I took up my position to watch. The prey were green Psyllid nymphs held in the wasp's mandibles at the junction of the thorax and abdomen. On arrival, the wasp landed a few inches below the entrance, or to one side, and walked straight to it, taking no notice of any other hole on the way. When it landed on the post above the hole, it started to walk upwards and then flew round in order to alight below the hole.

On arrival at the entrance, *Stigmus* released its grip, held the nymph with its front legs and then, with its head and jaws, pushed it into the burrow. Once when it dropped the nymph the wasp made no effort to retrieve it, but entered the burrow as though nothing had happened. On another occasion it found the burrow occupied by a male (or else another female looking for a suitable burrow). The wasp pushed in the nymph and followed. Presently it emerged again, tail first, dragging the nymph, which it allowed to drop and snapped at the intruder whose head had appeared at the entrance. Away flew the intruder. The owner then entered its burrow and presently flew away in search of another Psyllid nymph.

This wasp works both quickly and late. In 12½ minutes I saw it bring 12 nymphs to the burrow, staying ten to fifteen seconds inside, storing each one. I was then absent for nearly 40 minutes and after my return at 6.30 p.m. it made a series of journeys to and from the nest without carrying any prey. If it were carrying mud, the quantity was scarcely discernible. A tiny drop of gummy substance lay on the post half an inch below the entrance, and I noticed the wasp dipping its mandibles in this on three occasions before entering. From this observation I thought it likely that the wasp was closing a cell with some fine material and perhaps mixing it with a gummy substance deposited close at hand by the wasp itself.

Thinking that the main labours were ended for that day I walked along my other posts, but when I returned at 7.41 I saw it arriving with another nymph. During the next 24 minutes, 24 nymphs were brought to the nest, although by this time the sun had gone down behind the trees. After this the wasp made two further flights, each lasting two and a half minutes, and finally entered its burrow abdomen first at 8.10 for the night.

The wood was hard and difficult to split without damaging the cells, but these seemed to be arranged in linear fashion with a thin partition between each and to contain 25 to 37 Psyllid nymphs each.

Rhopalum clavipes (L.) and *Passaloecus corniger* Shuck.

Both these tiny black wasps were busy storing their nests in my garden posts at Ranmore, but unfortunately I took them to be one species at the time and may have confused their prey. This being the case, all I will say about them is that one (probably the former) was collecting Psocids and the other (probably the latter) Aphids. I have watched the latter storing its nest with Aphids at Cooden, Sussex.

Eumenidae.

Odynerus laevipes Shuck.

The hollow stems of Burdock and Alder in wood clearings at Ranmore provide nesting-sites for several wasps, including two species of *Odynerus*. One which I failed to capture, stored lepidopterous larvae in Alder stems, the other, *O. laevipes* Shuck., was twice found in Burdock stems. One of these stems, which I split open on July 22nd, 1945, had a hole in the side and there were three closed cells about three inches below it. Being evening, the wasp was sheltering for the night in the clear spaces above these.

The cells were all lined with mud and the partitions were also of mud. The lowest cell contained a full-grown wasp larva with no recognizable food remnants. The second cell had a wasp larva at the bottom and 21 Curculionid larvae of the genus *Hypera* (two different instars). Some of these beetle larvae supplied as food for the wasp larva had been parasitized by an Ichneumon (*Canidiella*), of which I found a pupa and two larvae in this cell. The third and uppermost cell contained 22 *Hypera* larvae and an elongate *Odynerus* egg at the bottom. The *Hypera* larvae were all jammed tightly together and showed signs of slight movement when released.

Earlier, on July 7th, I had opened another Burdock stem after seeing an *Odynerus* head peering out of the top of it. About six inches down I found one enclosed cell containing 22 *Hypera* larvae and an egg at the bottom.

In both cases where I found an egg, close examination showed no thread attaching it to the cell wall as is supposed to be the general rule for all species of *Odynerus*.

Odynerus spinipes (L.).

This wasp builds a curved funnel up to one inch in length from earth excavated from its burrow, cemented together with moisture from its mouth. In due course, when the nest is stocked, the funnel is demolished and the earth is used to seal the entrance.

Somewhat casually I have watched this wasp at work on steep banks at Upware (Cambridgeshire) and Silverton (Devon) and noted the cells were stored with up to 30 green larvae.

On July 1st, 1946, I found a colony at Ardingly (Sussex) nesting in a steep sandy road bank, which I watched on that day and also on July 6th.

The wasps were flying in with green beetle larvae held in the mandibles and supported by the front legs. The larvae were held just below the head. All at Ardingly were Curculionid larvae of the genus *Hypera*.

One wasp on which I concentrated brought in seven larvae in 54 minutes and then began closing the nest by moistening the edge of the funnel and preparing a pellet to use for its task. Every few minutes it flew away in order, no doubt, to replenish the supply of moisture oozed from its mouth.

The nests were about three inches in length. Cells had been excavated in the sides of the burrow. These were slanting downwards and contained an egg hanging on a stalk near the end of each which had been laid before the prey for that cell had been collected. These cells were not concentrated at the lower end of the burrow. Completed cells were closed with sand. Two completed nests comprised five and six cells respectively.

An incomplete nest with three cells contained 21, 25 and 27 green larvae ; a completed nest with five cells 17, 25, 24, 19 and 23 larvae ; a nest with six cells 20, 24, 23, 23, 26 and 26 larvae. All the larvae were of the same species. Freshly stored ones were alive and the others so fresh-looking as to make one think that the wasp venom must have some preservative properties.

Of the six cells in one nest, three contained eggs, which indicates that this wasp had probably collected 67 larvae in three days, because the eggs are supposed to take about three days to hatch.

I have spoken in Part I of the possible origin of the mud spout outside the burrows of this wasp. Ferton has suggested that the spout helps to preserve humidity. Other writers have suggested that it prevents parasites finding and entering the cells. There may be advantages, or there may have been advantages in the past, but it is noteworthy (*a*) that the spouts when broken are not renewed, and (*b*) that a Chrysid, *Chrysis viridula* L., has now thoroughly succeeded in mastering the camouflage, and I have watched it entering the nests both at Silverton and Ardingly.

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PROCEEDINGS OF THE ADJOURNED GENERAL MEETING ON 27 November 1947

Dr. S. M. Manton, Vice-President,
in the Chair.

The following films were shown at the Adjourned General Meeting of the Society, held at Film House, 142 Wardour Street, W. 1, at **5.0** p.m.

Infusorian World. By M. Jean Dragesco.

Feeding-process in *Dileptus gigas* (Protozoa). By M. Jean Dragesco.

[The commentary on Dr. Dragesco's films was given by Dr. Edward Hindle, F.R.S.]

The development of a moss, *Funaria*. (G.-B. Instructional Sound Film).

Some details in the life-history of the honey-bee. (G.-B. Instructional Film.)

[The commentary on this film was given by Miss Thora James, of G.-B. Instructional Films.]

Dr. S. M. Manton, Vice-President in the Chair, introduced the commentators and expressed the thanks of the Society to them and to G.-B. Instructional Films for allowing the meeting to be held in their hall.

PROCEEDINGS OF THE GENERAL MEETING ON 11 December 1947

Dr. A. Tindell Hopwood, Vice-President, in the Chair.

The Proceedings of the General Meetings held on Thursday, 30 October and 27 November 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. J. M. Black, Mr. K. T. St. George Cartwright, Prof. G. R. de Beer, Sr. Giuseppe de Toni, Dr. D. W. Goodhall, Prof. B. Livingston, Prof. B. Němec, Mr. J. W. Saunt, Mr. R. A. H. Flugge-de-Smidt, Dr. C. G. G. J. van Steenis, Dr. R. E. Vaughan, Mr. B. Verdcourt, Mr. W. G. Wallace, Dr. T. E. Wallis, Prof. F. E. Weiss, the Australian and New Zealand Association for the Advancement of Science, the Bentham-Moxon Trustees, Messrs. Longmans, Green & Co., Ltd., and the Royal Society of London.

The following Fellows signed the Obligation in the Roll and Charter Book, and were Admitted Fellows :—Mr. Clifford Charles Townsend, Mr. Llewellyn Cyril Lloyd, Mr. Claude Evrard Aldington Andrews, Dr. Walter Eric Montgomery and Dr. Lance Michael John Kramer.

The Vice-President in the Chair reported the death of Mr. Herbert William Pugsley, Fellow of the Society, and mentioned that the extensive monograph, '*A Prodromus of the British Hieracia*', which the Society was publishing, and of which the greater part had been read in proof by Mr. Pugsley, had occupied him for twenty years.

The following communications were read and discussed :—

Mr. Francis Rose. Small white butterflies caught by *Drosera anglica* Huds. (Discussed by Mr. A. J. Wilmott, Mr. F. C. Grigg, Dr. W. B. Gourlay and the Vice-President in the Chair ; Mr. Rose replied.)

Abstract.—

On 22 July 1947, Mr. R. Atkinson and I were examining a small bog on Bryant's Heath, near Norwich (E. Norfolk), for botanical purposes.

We noted the great abundance of all three species of sundew on this very restricted area, and were particularly struck by the exceptional size of the *Drosera anglica*, which was in flower and bore leaves up to six inches long.

We were surprised to note that very numerous specimens of the Small White butterfly (*Pieris rapae*) were fluttering on the surface of the bog. On closer examination, it was noticed that these were actually trapped by the leaves of *Drosera anglica*.

The other two smaller species of sundew, *D. rotundifolia* and *D. intermedia*, did not appear to have caught any butterflies. At a rough estimate at least a hundred specimens were trapped, and the noise of their fluttering was clearly audible some yards away.

It is interesting to note that *D. anglica* has the power to attract and trap insects as large as the Small White butterfly, and still more interesting to speculate on the cause of the attraction. Possibly the shiny droplets of secreted fluid on the leaf-glands are what stimulated the butterflies' interest so fatally. I understand that there is only one other report of butterflies being caught by *Drosera* before, and that is unconfirmed.

Mr. I. Henry Burkill. The ontogeny of the stem of the Common Bryony, *Tamus communis* Linn. (Discussed by Dr. I. V. Newman; Mr. Burkill replied.) (To be printed in the Journal, Botany.]

Abstract.—

An account of the stem from the seedling to the mature plant—(1) its zonation; (2) the determination of the divergence of its foliar organs by the size of the axis at their initiation; and (3) the control of the length of the very variable internodes through the partial nodal plates.

Dr. J. Jaramillo-Arango. Established fundamental facts in the history of *Cinchona*. (Discussed by Dr. J. Ramsbottom and the Vice-President in the Chair.) [To be printed in the Journal, Botany.]

Abstract.—

A review of the early history of *Cinchona*: How the Europeans got to know the properties of *Cinchona*. Who first introduced *Cinchona* into Europe. Confusion regarding the tree to which the name Quinaquina was applied. Etymological meaning of the word Quinaquina. Did the aboriginal indians know of the virtues of *Cinchona*? When *Cinchona* was introduced into Europe, and who first wrote about *Cinchona* in Europe and in England.

PROCEEDINGS OF THE GENERAL MEETING ON 22 January 1948

Professor G. R. de Beer, F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 11 December 1947, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Dr. L. H. Bailey, Mr. F. A. Sowter, Prof. F. E. Weiss, Dr. I. Vickery Newman, the British Council and the National Central Library.

The following Fellows signed the Obligation in the Roll and Charter Book, and were Admitted Fellows:—Mr. W. Warwick James, O.B.E., Mr. Harvey Lawrence Dunkley and Dr. Thomas Theodore Barnard, M.C.

The President reported the deaths of Dr. Charles Chamberlain Hurst and Mr. Ben Wells, Fellows; and Professor Pierre-August-Clément Dangeard, Foreign Member.

The following communications were read and discussed :—

Dr. J. Ramsbottom, O.B.E. Adam Zaluziansky (1558–1613) and the dichotomous key. (Exhibit.) (Discussed by the President; Dr. Ramsbottom replied.)

Dr. A. d'A. Bellairs, and Prof. R. Wheeler Haines. The anterior brain-case of tetrapods, with a consideration of the interorbital septum. (Discussed by the President and Dr. Malcolm Smith; Dr. Bellairs replied.)

Abstract.—

The variations in the disposition of the trabeculae and orbital cartilages throughout the tetrapod series were described. In most primitive tetrapods the skull was tropitrabic, and the brain-case well ossified. Substantial modification away from this condition has occurred in most living forms. In many modern reptiles the skull has remained tropitrabic, but the extent of ossification has been greatly reduced. The contrast between the condition in the lizards, on the one hand, and the snakes and amphisbaenids on the other, was considered and the taxonomic implications of these findings were discussed.

Dr. K. R. Sporne. Correlation and Classification in Dicotyledons. (Discussed by the President, Dr. H. Hamshaw Thomas, M.B.E., Mr. A. J. Wilmott and Dr. R. Melville; Dr. Sporne replied.) [Printed in full below.]

Dr. J. Ramsbottom, O.B.E. Demonstration of a new projector for showing Kodachromes. (Slides of Reptiles and Fungi, taken by Mr. Paul de Laszlo were shown by Dr. Malcolm Smith and Dr. J. Ramsbottom. Mr. Paul de Laszlo also spoke.)

CORRELATION AND CLASSIFICATION IN DICOTYLEDONS

By Kenneth R. Sporne, M.A., Ph.D.
(The Botany School, Cambridge.)

(With 1 text-figure.)

In recent years the relationship between phylogeny and taxonomy has been much discussed, and an excellent review of the subject has been provided by Turrill (1942). There are some, like Gilmour (1940), who claim that a natural classification should not be based on ideas of phylogeny, but should merely group together individuals having a large number of attributes in common. Nevertheless, most taxonomists would probably agree that the ideal classification of living organisms would be one which, even if not based on phylogeny, at least included evolutionary ideas. In this communication the writer puts forward some tentative suggestions as to how this ideal classification may ultimately be realized, and although most of the remarks apply particularly to the classification of the Dicotyledons, the general principles are applicable to any large group of living organisms.

Most of the so-called phylogenetic classifications which claim to show how living organisms were derived one from the other during their evolution have been in the form of a tree in which " primitive " groups are at the bottom and " advanced " at the top, while intermediate groups are arranged along the

branches according to various graded series of characters. Whether such graded series correspond to the evolutionary sequence of characters or not, such a classification makes a grave error in assuming that present-day organisms exist contemporaneously with their ancestors, and while this assumption is justifiable when considering small units such as species or even genera, it is not justifiable when considering larger units. It is most unlikely that the origins of present-day families can be found in the flora or fauna of to-day. Present-day families represent the twigs of the tree of evolution and cannot be assumed to be part of its main structure as well.

Some botanists, however, go further than this and challenge the concept of a tree of evolution on the grounds that a system of successive dichotomies allows no scope for recombination by hybridization. In its place Hayata (1921) suggested a dynamic system of classification which has been likened to a creeping plasmodium whose branches separate and recombine as they grow up through time. Some such allowance for recombination must be made at species level and even, perhaps, at genus level, for several examples are known of new species resulting from a process of hybridization. But, when two branches have diverged sufficiently to warrant family status, then the possibility of recombination must be remote. Perhaps the best concept to adopt is that

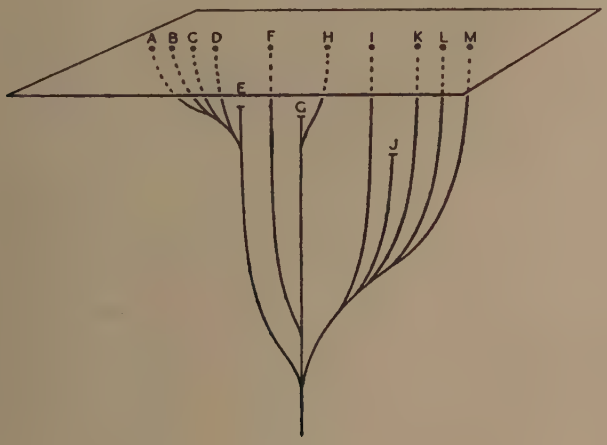

Fig. 1.

proposed by Lam (1935). This lies somewhere between the rigid dichotomous tree and the fluid plasmodium. The present day is represented by a horizontal plane on which related groups of organisms are arranged according to their affinities, while beneath them is constructed a tree-like structure to indicate how they were related in past ages. The main branches of this structure once formed remain distinct, but are sufficiently wide and plastic to allow recombinations within them.

Such a concept is certainly a great advance on previous classifications, since it recognizes the fact that present-day families correspond to the tips of the branches of the evolutionary structure. It now becomes possible to indicate, not only those families which are closely related, but also those which are ancient in origin and those which are recent. It has often been assumed that an ancient family is necessarily a primitive one and that a recent family is necessarily advanced, but this confusion probably results from a failure to realize the exact implications of the term "primitive", as applied to characters and to families. A primitive character is one which, possessed

by present-day families, was also possessed by their ancestors. Such a character is clearly at the same time an ancient one. A primitive family is a present-day family which has retained a relatively large number of primitive (and ancestral) characters, and has diverged very little from the ancestral. Such a family would be described as ancient, only if the point at which it originated was early in evolutionary time—*i. e.* if it branched off near the base of the evolutionary tree. An advanced family, on the other hand, is one which has diverged a long way from the ancestral type or which has retained relatively few primitive characters. Such a family may be ancient or recent according to whether it became recognizable as a separate family early or late in evolution. Fig. 1 may help to make clearer this distinction between the terms ' primitive ' and ' ancient '. The diagram is intended to represent a portion of the evolutionary tree where the families which terminate the branches (some of which became extinct during past ages) are labelled A to M. Each time a new branch arose it is assumed that an advancement occurred ; either an ancestral character was lost, or an advanced character was gained, or an ancestral character was lost in favour of an advanced one. The most advanced families are A and M, in whose evolution the greatest number of branches has occurred, yet A is a recent family while M is comparatively ancient. Families F and H are primitive, since they have diverged only once from the ancestral, yet H is a recent family while F is ancient.

As far as the Angiosperms are concerned, in the absence of fossil evidence, it is not yet possible to assign any degree of relative antiquity to the various families. But there is hope that ultimately the endeavours of palaeobotanists will enable this to be done. It now remains to discover to what extent, and by what means, the relative primitiveness or advancement of families can be indicated in phylogenetic classifications. The problem is to discover some criteria of primitiveness which are genuinely objective and do not invite the criticism of argument in a circle, thus—' these characters are primitive because they are possessed by primitive families and those families are primitive because they possess primitive characters '. In the classification of the Dicotyledons, it has usually been a matter of arranging families according to some graded series of characters, coupled with the statement that those at the beginning of the series are primitive and those at the end advanced. But, as has often been pointed out, any series from A to Z can equally well be read in the opposite direction from Z to A, or even from M reading in opposite directions towards A and Z respectively. Too often the decision has been a matter of personal preference, as is shown by the wide differences of opinion as to the nature of the primitive flower. Those who read the series from unisexual flowers to bisexual regard the Amentiferae as primitive, while those who read the series in the opposite direction regard them as advanced. Many botanists have reluctantly concluded in recent years that, with the information at our disposal, this problem cannot be solved. Thus, Bancroft (1930) remarked that it is not possible to say of any Angiosperm living or fossil, ' This is a primitive Angiosperm '. But the writer is of the opinion that the situation is not so hopeless as this, and that, even in our present state of knowledge, it is possible to raise the study of phylogeny above the level of mere speculation and to say with a fair degree of certainty which families are primitive and which advanced.

The key to the problem lies in the definition, given above, of a primitive family. If, as suggested, primitive families possess more primitive characters than the average family, it follows that primitive characters occur together more often than they would if distributed evenly throughout the world flora. The following example, worked out in the accompanying table, may help to elucidate this principle.

Let us suppose that, among a total of 100 families ($n=100$), there are 70 advanced and 30 primitive families. Two characters P and Q, neither of which

has any evolutionary significance, are distributed in such a way that 30 per cent. of the n families possess character P and 60 per cent. character Q. Since neither character is primitive or advanced, both are distributed evenly throughout the n families, with the result that the number of families with both characters is 18, as shown in column (1) of the table. Characters X and Y also occur in 30 per cent. and 60 per cent. respectively of the n families, but, being primitive characters, they are not distributed evenly. Thus, in column (2), character X is distributed between advanced and primitive families in the proportion of 18 to 12 (instead of 21 to 9, as in the case of P) and character Y in the proportion of 35 to 25 (instead of 42 to 18, as in the case of Q). Under these circumstances the total number of families possessing both X and Y is found to be 19.

TABLE I.

		(1) Distribution of characters P and Q which are neither primitive nor advanced, and are distributed evenly over the n families. No. of families with P $=30\%$. No. of families with Q $=60\%$.	(2) Distribution of characters X and Y which are both primitive and occur more often among primitive families. No. of families with X $=30\%$. No. of families with Y $=60\%$.
Total number of Families $n=100$.	Advanced Families 70%.	No. of advanced families with P$=30\%$ of 70 $=21$. No. of families advanced with Q$=60\%$ of 70 $=42$. No. of advanced families with both P and Q $=\frac{21\times42}{70}=12{\cdot}6$.	Suppose that the number of advanced families with X$=18$. and with Y$=35$. Then, the number of advanced families with both X and Y would be $\frac{18\times35}{70}=9$.
	Primitive Families 30%.	No. of primitive families with P$=30\%$ of 30 $=9$. No. of primitive families with Q$=30\%$ of 60 $=18$. No. of primitive families with both P and Q $=\frac{9\times18}{30}=5{\cdot}4$.	Suppose that the number of primitive families with X$=12$. and with Y$=25$. Then the number of primitive families with both X and Y would be $\frac{12\times25}{30}=10$.
		Total number of families with both P and Q 'm_1'$=12{\cdot}6+5{\cdot}4$ $=18$. or $m_1=\frac{p\,.\,q}{n}=\frac{30\times60}{100}$ $=18$.	Total number of families with both X and Y 'm'$=9+10$ $=19$.

Thus it is seen that a small shift away from random distribution of two characters (3 per cent. in one case and 7 per cent. in the other) causes an increase (1 per cent.) in the frequency of their occurrence together. A larger shift would produce a correspondingly larger increase. Similarly it can be

demonstrated that two advanced characters also tend to occur together more often than would be expected on a random distribution, and that an advanced and a primitive character tend to occur together less often than would be expected.

This provides a useful test for determining which characters are indicators of evolutionary advancement, though it must be borne in mind that two characters might depend physiologically or genetically on each other for their expression ; in which case, they too would tend to occur together more often than on a random distribution. But, when large numbers of characters show correlations when taken in pairs, it is highly improbable that they are all determined by the same physiological or genetical factor. Under such circumstances it can be taken that a positive correlation between two characters indicates either that both are primitive or that both are advanced, while a negative correlation between two characters indicates that one is primitive and the other advanced.

The procedure is to list as many as possible of the characters used in the standard classifications of Dicotyledons, to examine the frequency of their occurrence together in pairs and to compare this frequency with that calculated on a random basis. Supposing there to be 'n' families of Dicotyledons, of which 'x' possess the first character and 'y' the second, then if both were distributed at random throughout the n families, the expected occurrence together of both characters 'm_1' would be $\frac{x \cdot y}{n}$. If it is found that the actual occurrence 'm' is significantly different from m_1, then it is concluded that the two characters are correlated. If m is greater than m_1 the correlation is positive and if it is less the correlation is negative. For assessing the significance of the difference between m and m_1, use is made of Pearson's χ^2 test, the application of which is described by Fisher (1936). Using the symbols quoted above, the value of χ^2 is given by the following expression :—

$$\chi^2 = \frac{(m-m_1)^2}{x-m_1} + \frac{(m-m_1)^2}{y-m_1} + \frac{(m-m_1)^2}{m_1} + \frac{(m-m_1)^2}{n+m_1-x-y}.$$

Then the value of 'p' which corresponds to this value of χ^2 (the number of degrees of freedom being 1) can be obtained from tables. The smaller the value of p, the greater is the probability that m is really different from m_1 and the more significant is the correlation. The threshold value of $p=0{\cdot}02$ has been taken as the limit above which no correlation is regarded as significant.

In making calculations of this kind, some allowance must be made for families with mixed characters, *i. e.* for families in which some genera show a particular character and some do not. This can be done by making two complete sets of calculations, one including such families as possess the character 'non-exclusively' and the other including only those families in which all genera possess the character ('exclusive'). This difficulty is small, however, compared with that raised by incompleteness of data. Frequently it has proved impossible to determine from the standard works whether a certain character is possessed by a particular family or not. It is then necessary to limit the value of 'n' to the number of families about which information is available. In view of this, all the conclusions must be regarded as tentative, and liable to revision as more information becomes available.

The idea that characters may be correlated in pairs is not a new one, but was used by Sinnott and Bailey (1914), and since that time by many others. Sinnott and Bailey showed that the presence of stipules is associated with the number of vascular bundles entering the leaf from the node, and, had they assigned a statistical probability to their figures, they would have found that they correspond to a value of $\chi^2=29{\cdot}94$, or a probability of very much less than 0·02,

and represent a highly significant correlation. Now it is conceivable that, in this case, the correlation might be brought about because stipules are in some way connected with vascular supply. But such an explanation would hardly apply to a correlation between glandular leaves and vascular bundles in the integuments of the ovules ; yet such a correlation exists and the value of $\chi^2=18{\cdot}5$, corresponding to a probability of very much less than 0·02 shows it to be highly significant. (The list of families with glandular leaves is taken from Hutchinson (1926) and of those with integument bundles is taken from Le Monnier (1872) and Netolitzky (1926).) It is difficult to see how glands in the leaves could possibly influence the development of vascular bundles in the integuments of the ovules, and it is taken that this correlation indicates that both characters are either primitive or else advanced.

Now, each of these characters shows further positive correlations as follows :—

Glandular leaves	with Arboreal habit.
	,, Arillate seeds.
	,, Numerous stamens.
Integument bundles	,, Woody habit.
	,, Numerous stamens.

These characters, too, show positive correlations among themselves and with other characters :

Arboreal habit	with Arillate seeds.
	,, Stipulate leaves.
Woody habit	,, Alternate leaves.
Arillate seeds	,, Stipulate leaves.
Alternate leaves	,, Trilacunar node (*i. e.* leaves receiving three vascular bundles).

It will be noticed that the trilacunar node and the possession of stipules come into this scheme independently as indicators of primitiveness or advancement. So the correlation shown by Sinnott and Bailey was apparently not merely the expression of some functional inter-dependence, but was due to their being characters of evolutionary significance as Sinnott and Bailey suggested. In a similar way it is possible to show that correlations exist between characters which are alternatives to those listed above. Thus, the herbaceous habit is positively correlated with a meiomerous androecium. There is also a negative correlation between the herbaceous habit and the possession of integument bundles.

Here, then, are nine characters, all of which are indicators of evolutionary advance, but, in the absence of further evidence, it would not be possible to say whether they represent primitive or advanced characters. Such evidence can, however, be found in the fossil record, despite its incompleteness, for it is found that many of the characters mentioned above are more abundant in fossil families than they are in the flora of the world to-day. Reid and Chandler (1933) listed 41 families of Dicotyledons whose remains they had identified in the London Clay deposits of Eocene age, and an examination of these families shows that they tended to have, among others, the following characters :—

Glandular leaves.
Alternate leaves.
Integument bundles.

Another list of fossil remains is that compiled by W. N. Edwards (1931), in which 47 families are mentioned whose woody remains have been identified

from periods prior to the Pleistocene. These families are found to possess a higher proportion with the following characters than do the woody families of the present day :—

Glandular leaves.
Stipulate leaves.
Integument bundles.

From this it must be concluded that the nine characters mentioned above must be primitive and not advanced.

In all, the writer has, so far, found a total of eighty correlations, twelve of which are concerned with existence in the fossil record, while the remainder are inter-correlations between floral and vegetative characters. With the exception of two, which seem to be at variance with the rest, these correlations support each other and fit together in a remarkable way to establish a total of twenty-two characters which can all be used as indicators of primitiveness.

The ' primitive flowering plant ' was, apparently, a tree with alternate, stipulate, glandular leaves, each leaf receiving three vascular bundles. It had unisexual, haplochlamydeous, actinomorphic flowers with free perianth members. Its flowers had many stamens and many carpels, its ovules had two integuments in which were vascular bundles, and its seeds were invested with an aril. It probably had leaves with a toothed margin, flowers which were wind-pollinated and seeds with abundant endosperm. Corresponding with each of these primitive characters, there has been a trend in evolution towards the alternative advanced condition, *e. g.* from unisexual to bisexual, from actinomorphic to zygomorphic, from polypetalous to gamopetalous, etc.

It is now possible to examine the families of Dicotyledons one by one, to see which are the most primitive and which the most advanced. If, in each family, one ' mark ' be scored for exclusive possession of an advanced character, and half a mark for non-exclusive possession, a rough estimate of the percentage advancement (' advancement index ') can be calculated. Taking the fourteen characters best established as indicators of primitiveness (*i. e.* those with the greatest number of correlations to support them), it is found that at the top of the scale come the Labiatae, Martyniaceae and Phrymaceae with a score of 100 per cent. Next come the Gesneriaceae and Pedaliaceae at 96 per cent. and the Dipsacaceae, Gentianaceae, Polemoniaceae and Valerianaceae at 93 per cent. The Compositae are surprisingly low down the scale with a score of only 65 per cent.

At the other end of the scale it is interesting to find that no family has a score of 0 per cent. The families which approach most nearly to the ancestral Dicotyledon are the Flacourtiaceae at 7 per cent. and the Euphorbiaceae at 11 per cent. Next come the Fagaceae at 17 per cent. and the Dilleniaceae at 25 per cent., followed by the Magnoliaceae, Nymphaeaceae and Salicaceae at 27 per cent. Thus, both the Amentiferae and the Magnoliales have some very primitive representatives, but neither of them approaches so near to the ancestral type as do the Flacourtiaceae or the Euphorbiaceae.

Finally, it remains to suggest how this idea of an advancement index could be incorporated into a scheme of classification. The three-dimensional scheme suggested by Lam (1935) for the Eumadhuceae arranges the present-day genera of that group in a horizontal plane according to their geographical distribution. It is suggested that, for the families of Dicotyledons, a similar three-dimensional scheme be used, but that the families should first be arranged according to their advancement index. Concentric circles could be drawn in the horizontal plane, corresponding to percentage advancement, and the families, having been placed in their appropriate rings, could then be moved round and their position adjusted according to their local affinities (determined for the most part by characters other than those used in calculating the advancement

index), so that related families are placed near each other or on the same radius. It must, however, be realized that the advancement index is not a fixed figure, but will change as more and more characters are established as primitive or advanced. But, on the other hand, the addition of new facts should cause less and less rearrangement as the scheme approaches to the ideal natural classification. It would then remain for the tree of evolution to be constructed beneath this classification, so as to show the relative antiquity of each family; but, as already pointed out, the information on which this depends is buried in the rocks, and will only become available after many years of labour with a geological hammer.

Note. This communication is a preliminary account of work which will shortly be published in greater detail.

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PROCEEDINGS OF THE GENERAL MEETING ON 12 February 1948

Professor G. R. DE BEER, F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 22 January 1948, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Sir Gordon Gordon-Taylor, Mr. F. C. Grigg, Mr. Reginald L. Hine, Messrs. Crosby Lockwood and Son, Ltd., the Anti-Locust Research Centre, British Museum (Nat. Hist.), the McGraw Hill Publishing Co., Ltd., and the Marine Biological Station, Millport.

The following Fellow signed the Obligation in the Roll and Charter Book, and was Admitted a Fellow :—Mr. Roland Mark Underhill.

The President announced the award of this year's Linnean Medal to Dr. AGNES ARBER, F.R.S., F.L.S.

The following communication was read and discussed :—

Professor W. V. Mayneord. Some applications of nuclear physics in biology and medicine. (Discussed by the President and Mr. F. C. Grigg ; Prof. Mayneord replied.)

Abstract.—

Recent developments in nuclear physics have made available a wide range of artificial radioactive substances with many applications in both biology and medicine. These substances may be produced on a large scale in a variety of ways, but principally by nuclear fission in a chain reacting pile. Examples of nuclear reactions resulting in useful isotopes, and brought about in this way, were described. Very small quantities of artificial radioactive isotopes may be used as 'tracers' to study metabolism in both plants and animals, while larger quantities themselves bring about demonstrable biological effects and may be used therapeutically. Examples were discussed of the use of biology and medicine in isotopes of carbon, phosphorus, iodine, sodium and iron.

Nuclear physics requiring high energy particles and quanta for nuclear disintegrations has made available new weapons in biology and medicine. Recent experiments with very high-voltage X-rays produced by a synchrotron were described and their possible therapeutic applications indicated.

Apparatus designed to detect and measure radioactive isotopes was demonstrated.

The President made an announcement that the Council had specially appointed Capt. Cyril Diver, C.B.E., Dr. W. E. Swinton and Mr. A. H. G. Alston, as representatives to attend a Public Local Enquiry at Wareham on 16 March 1948, in connection with the Lulworth and East Holme Services Training Area. The Fellows expressed unanimously their approval of this action.

PROCEEDINGS OF THE GENERAL MEETING ON 26 February 1948

Professor G. R. de Beer, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 12 February 1948, having been circulated, were taken as read and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Dr. Jean Balazuc, Mr. Lowell J. Reed, the Crown Agents for the Colonies and the Provisional International Union for the Protection of Nature.

The following Fellows signed the Obligation in the Roll and Charter Book, and were Admitted Fellows :—Dr. Gopal Singh Puri and Dr. Frank Greenshields.

The following Exhibits were shown :—

Major J. E. Adlard. A collection of plant paintings by Mary and Emma Osborn.

Mr. Peter R. Bell. Stelar structure in the genus *Elaphoglossum*.

Miss W. M. A. Brooke. Drawings of Basutoland plants.

Professor G. D. Hale Carpenter, M.B.E. The polymorphic African mimetic butterfly, *Pseudocraea eurytus*.

Dr. E. M. Delf, and the Scottish Seaweed Research Association. Commercial products derived from Seaweeds.

Dr. G. E. Fogg. Water-colour drawings of Blue Green Algae.

Dr. F. W. Jane. Photomicrographs of Timbers.

Mr. Bernard Alwyn Jay. Macroscopic photographs for the identification of Conifers.

Dr. M. T. Martin. Some parasitic Red Algae.

Miss B. Moss. Stages in development of the attaching disc in *Fucus vesiculosus*.

Miss M. Naylor. Liberation of oospheres in *Fucus spiralis* and in the Australian fucoid *Scytothalia*.

Mr. M. Omarkhan. The Lateral Sensory Canals of Larval *Notopterus*.

Professor W. H. Pearsall, F.R.S. Photographs of Mountain habitats of plants.

Mr. W. R. Price. Volume of paintings on vellum of plants, insects and birds dated 1608, *à Poitiers*.

Dr. G. S. Puri. Photographs of Fossil plants of the Himalayas.

Royal Microscopical Society. Historical Collection of micro-slides.

The Royal Society. (*a*) Malpighi MSS. and drawings; (*b*) Scheuchzer MSS. and drawings; (*c*) The Richard Waller drawings of plants; (*d*) Collection of plant paintings which belonged to Philip Miller.

Mr. S. Savage. (*a*) An Herbarium of the Bobarts; (*b*) Cast from recently-discovered mould of Sergel's medallion-portrait of Linnaeus.

Mr. N. G. Stephenson. Developmental adaptation of the Primitive Anuran genera, *Leiopelma* and *Ascaphus*.

Miss Lillian Snelling, Miss H. D. Garside, Miss Heather Child and Stella Ross-Craig. Recent water-colour drawings of British Wild Flowers. (Lent by courtesy of The Medici Society.)

Miss H. D. Garside. Water-colour drawing of Fungi.

[*Abstracts describing these Exhibits are printed below.*]

A collection of plant paintings by Mary and Emma Osborn.

By Major J. E. Adlard.

This collection belongs to Mrs. A. M. Tomkins, of Ullswater, London Road, Knebworth, Herts.

Mary and Emma Osborn appear to have been relations of Robert Osborn, who from October, 1835 was sole proprietor of the Fulham Nursery, which had been occupied previously by the Burchell who was the father of W. J. Burchell, the South African explorer.

This collection of plant paintings extends over a period of some fifty years. The paintings are usually dated, and in some instances bear the names of the places these ladies visited.

A certain amount of text is included, mostly copied from printed works; and an attempt to compile a dictionary of the derivations of generic names is left unfinished.

Drawings of Basutoland plants.

By Miss Winifred M. A. Brooke.

Sketches of specimens from the collection made for the Department of Botany of the British Museum in the Basutoland Protectorate from November, 1937–March, 1938. The plants were collected in the course of travels, mostly on horseback, from Roma and Morija in the west by way of the Maluts-anyane Falls to Quacha's Nek in the east, thence north to Mohotlong and, finally, over the Sani Pass to Underberg in Natal.

The valleys traversed were from 5,000–8,000 ft. in height, the passes and many bridle paths being 10,000 ft.

Polymorphism.

By Prof. G. D. Hale Carpenter, M.B.E.

The seven boxes show various forms of the African mimetic butterfly, *Pseudacraea eurytus* first described by Linnaeus from the West Coast, black and white, female. Many ' species ' were subsequently described ; they are now treated as forms of a ' species complex ' extending from the Gambia to northern Angola on the west, and eastwards through Nigeria and the Congo into Uganda and the east coast of Lake Victoria.

An isolated form occurs near Mount Kenya, and several others in the coastal district of Kenya Colony, and Tanganyika Territory, linked with others in Nyasaland, Natal, and even Pondoland, south of Natal. No form is known from the Zambezi basin, although several occur in the extreme south of the Congo basin. The species is not found in Zanzibar or in Madagascar but does occur in some of the islands off the Guinea Coast.

Wherever it occurs it is closely mimetic of numerous species of the typically aposematic Acraeine genus *Bematistes* (=*Planema*), sex mimicking sex. The numerical prevalence of any species of *Bematistes* determines the predominating form of *Pseudacraea* in that locality.

The eighth box shows some examples of model *Bematistes* with their mimetic *Pseudacraea*.

The series was got together for illustrating a study of the species. Thanks are due to the Keeper of Entomology, British Museum (Natural History), for kindly allowing specimens to be exhibited from the national collection. Others are from the Hope department of Entomology, University Museum, Oxford.

Commercial products derived from Seaweeds.

By Dr. E. M. Delf.

The exhibits formed the illustrations to a previous account of the subject given to the Society at a General Meeting, in the autumn, 1947. They include products from the two great groups of the *brown* and the *red* seaweeds.

The scheme showing the numerous products derived from the brown seaweeds was sent by the Scottish Seaweed Research Association and is shown with the permission of the Director. Samples are shown of four products, as marked on this scheme by courtesy of the firms and Institutions mentioned, namely :—

Calcium alginate	Cefoil Ltd.
Transparent ' paper '	Cefoil Ltd.
Yarn for textiles	Cefoil Ltd. (uncoloured).
	Courtaulds Ltd. (coloured blue, dyed ; pink, from metallic salts used in manufacture.)
Fabrics	
Green ribbon, as used for camouflage, lent by...	Scottish Seaweed Research Association.

Certain red seaweeds are used as a source of agar and agar-like derivatives (lists given). *Pure agar* is used for fungal cultures, and for bacteriological work, and is derived mainly from *Chondrus crispus*. Agar-like derivatives are derived from other red algae and are used for many purposes (especially glues and as components of food products), as are alginates. The sample of *Chondrus* is as supplied commercially (after washing, bleaching and drying) from Ireland in pre-war days. The *pure agar* exhibited was prepared from a commercial sample by Dr. Paul Haas.

Certain seaweeds are used locally as a source of food (lists given), for instance, Alaria (brown; eaten fresh or cooked) and Porphyra (red; eaten cooked or dried). The latter is dried, pressed and sold as a delicacy in Japan, under the name 'Asakusanori', and in pre-war days was also exported to California. The sample was sent by a friend from this region.

The kelp powder and the *Fucus* tablets can be bought at most Health Food Stores; they are used to provide a source of iodine in the diet, usually for medicinal purposes.

Seaweed as a manure and as a component in animal feeding stuffs is not yet a commercial proposition in this country; their possibilities are, however, being actively investigated.

Water-colour drawings of blue-green Algae.

By G. E. Fogg.

Five ink and water-colour drawings were exhibited. Of these, three are original, about 20×27 cm. in size, and depict the following algae: *Anabaena cylindrica* Lemm. (scale, ×3,000), *Scytonema* sp. (scale, ×850), and *Petalonema alatum* Berk. (scale, ×500). The other two, which were painted by E. F. Wilkinson, Esq., after sketches by the exhibitor, are each about 30×40 cm. One represents a portion of a colony of *Gloeotrichia natans* Rabenh. (scale, ×1,600), the other is of a group of algae from a wet rock face, Salen, Isle of Mull, including *Petalonema alatum* Berk., *Gloeocapsa alpina* (Näg.) Brand and *G. montana* Kütz. (scale, ×1,250).

Photomicrographs of Timbers.

By Dr. F. W. Jane.

Dr. Jane showed a number of photomicrographs illustrating the structure of wood. The exhibit included illustrations of a number of dicotyledonous woods, mostly of low power transverse sections to illustrate the characteristic arrangement of the elements in different species, and some high power photomicrographs of coniferous woods, largely radial longitudinal sections to illustrate pitting in the vertical tracheids and ray cells. There were also some photographs of compression wood in Spruce, for comparison with others of normal wood from the same tree: transverse sections showed the rounded vertical tracheids and intercellular spaces of the compression wood and in longitudinal sections the characteristic checking of the walls of these elements.

Macroscopic photographs for the identification of Conifers.

By Bernard Alwyn Jay.

The macroscopic photographs of conifer shoots exhibited showed the application of a particular method of photography which seems to have certain definite advantages for botanical and zoological illustration. Accurate and naturalistic pictures of small details can be obtained very speedily, once the requisite apparatus is set up, with magnifications ranging from ×2 (or even less) to ×20.

A stand camera with a triple extension was used, giving a bellows length of about 2 ft.; the lens had a focal length of 5½ in.; quarter-plates were used. By this means a magnification of ×4 on the negative was obtained. Subsequent enlargement to ×9 was made with very little loss of definition. This final magnification was adopted, as it approximated to that of most generally used pocket lenses.

The selection of photographs exhibited are part of a collection of some 180 photographs of the commonest and most useful species of Coniferae grown in this country.

Some parasitic Red Algae.

By Dr. M. T. Martin.

During the last few years in South Africa a number of red algae have been collected which grow parasitically on other red algal hosts. Eight of these were selected for exhibition: two of them (*Syringocolax macroblepharis* Reinsche and *Stromatocarpus parasiticus* Falk.) have been described before, but of the remaining six, five are new species and one probably a new genus. These parasites show several characteristic features in varying degree:

(1) Red pigmentation is partly or entirely lacking, so that the parasite appears pale pink or often a shining white in contrast to the pigmented host thallus.

(2) The vegetative plant body is extremely reduced. Most of the parasites form small compact pustules on the surface of the host, and the thallus is often reduced as far as is compatible with the bearing of reproductive organs.

(3) Rhizoidal filaments from the parasite penetrate the host tissues, and in most cases enter into communication with the host cells by means of wide pit connections.

It is also interesting to note that many of the parasites bear a close relation systematically to the hosts on which they grow.

Stages in development of the attaching discs of Fucus vesiculosus.

By Miss Betty Moss.

A selection of photomicrographs and slides were exhibited, demonstrating stages in the development of the attaching disc of *Fucus vesiculosus*. Attachment of the young sporeling is secured by a thick envelope of mucilage which surrounds the rhizoids. These rhizoids are reinforced later in development by down-growing hyphae which originate from the internal tissues of the sporeling. These hyphae interweave, and in the disc of a mature thallus some grow out at right angles to the upper surface of the disc and there segment to form a ' pseudo-cortex '.

Preparations of attaching discs of *Fucus vesiculosus* on a variety of substrates were shown. Sporelings cultured on a substrate of glass develop unbranched and richly pigmented rhizoids of great length. In contrast, sporelings of a similar age, cultured on a substrate of pith, have numerous rhizoids which penetrate through the cells of the substrate and branch freely. Attaching discs of mature thalli collected from a breakwater had hyphae penetrating down through the tracheids of their substrate of coniferous wood. Yet the attaching disc of a mature thallus of *F. vesiculosus* attached to *Ascophyllum nodosum* showed no signs of hyphal penetration into the ' host '. Instead, the attaching disc of *Fucus* had stimulated the meristoderm of *Ascophyllum* to great activity, so that it gave rise to cortical filaments which grew up into the disc of *Fucus*. These observations indicate that development of the attaching disc of *Fucus vesiculosus* is greatly influenced by the nature of the substrate.

The Liberation of the Oospheres in Fucus spiralis and in the Australian fucoid Scytothalia dorycarpa.

By M. Naylor.

The first part of the exhibit consisted of a dried receptacle of *Fucus spiralis*, set up under a binocular microscope, showing extruded egg packets extending in chains from the obstacles. There was a photomicrograph of one of these chains, showing over thirty egg packets, still enclosed in the mesochiton, adhering end to end, with packets of spermatozoids embedded between them.

The rest consisted of series of drawings and photomicrographs illustrating the development and liberation of the oospheres of *Scytothalia dorycarpa*, an Australian fucoid of almost entirely submerged situations.

The single oosphere contained in the oogonium has a characteristic 'amphora' shape, and is surrounded by a complex wall of three distinct layers. The innermost is a thin membrane, the *endochiton* ; the middle region, the *mesochiton*, is very swollen and mucilaginous, and is itself composed of three concentric layers ; surrounding the whole is a further membrane, the *exochiton*. Separating the exochiton and the mesochiton, in the distal region only, is a specialized portion of the mesochiton, the *mesochiton collar*. This is tougher than the rest of the mesochiton, and consists of a folded ring of material, of ear-like appearance in optical section.

The oosphere, surrounded by the swollen mesochiton, escapes from the exochiton, but remains attached to it by a stalk formed by the elongation of this folded mesochiton collar. The oosphere is thus able to pass out into the sea, and yet still be retained on the parent plant, a feature of biological importance in relation to fertilization.

The Lateral Sensory Canals of Larval Notopterus.

By M. Omarkhan, M.Sc.
Department of Embryology, University College, London.

In larval Notopterus (a teleost of tropical freshwater) the latero-sensory canals in the head are extraordinarily spacious and run through the head like huge tunnels. The canal system on the head is remarkable in not possessing any opening to the exterior. The disposition of the canals follows the generalized teleostean pattern ; there are thus supraorbital, suborbital, horizontal and operculomandibular canals and a supratemporal diverticulum. Altogether 36 neuromasts are present within the canals on each side of the head innervated in the typical manner. The lateral canal of the body has not yet formed and is represented by a row of free sense organs exposed on the surface. The development of the latero-sensory system shows some modifications in comparison to other teleosts. Primary pores are not formed as in other teleosts, but the system arises from the early stages as a closed system in the head region. The temporal portion of the horizontal canal attains an association (not a communication) with the perilymphatic space of the internal ear through a lateral cranial vacuity in the skull. In *Gymnarchus* and in some members of the Gadidae, Muraenidae and Clupeidae there is also an association of varying degrees present between temporal canal and the ear. It is suggested that as a result of this association the sensory canal system tends to become modified in two ways : (*a*) reduction in the external communication, ultimately in some forms leading to a total loss, and (*b*) increase in the size of the canals. Notopterus shows a high degree of specialization in these directions. Other fishes showing such modifications can be placed in a sequence in accordance with the degree of the development of these specializations.

Photographs illustrating Mountain Habitats.

By Prof. W. H. Pearsall, F.R.S.

This exhibit was divided into three parts, of which the first consisted of photographs of vestigial woodlands in northern England and the western Highlands. The second part was composed of photographs showing the instability of characteristic mountain surfaces. The third part consisted of photographs of geological features of interest to botanists.

A volume of Paintings on vellum dated 1608.

By W. R. Price.

The title-page has a coat-of-arms, but no title. It bears the date 1608, and *à Poitiers*. Both sides of the vellum has been used, and the contents are more of the nature of a sketch-book than of a planned work. The coat-of-arms is signed *van Kuyk*; and a later inscription in pencil at the base of the title-page refers to him as the pupil of a Van Kessell, a Flemish painter. The paintings include birds and insects, and a landscape in double panels, the upper one a view of Poitiers and the lower one a Dutch or Flemish town.

The History of the Micro-slide : Exhibited by The Royal Microscopical Society.

By F. C. Grigg.

The exhibit comprised several hundreds of slides from the Historical and Modern collections of the Society, from the old Ivory sliders of Leeuwenhoek's time with talc windows which were supplied in sets by the makers of Microscopes up to the early 1800's to the most modern examples of cover-glass slides for observations of both sides of the object and macro-sections of earthworms used for student demonstrations. There were also the foot-long wooden sliders for early Solar microscope demonstrations containing whole wings of Dragon-flies, etc. The first examples of the 3 in. × 1 in. glass slides as standardized by the Society were shown together with notable mounts of insect dissections, and arranged slides of Foraminifera characteristic of the latter half of the past century set a standard unsurpassed to-day. Numbers of early slides covered with coloured paper showed the artistic tendencies of the Victorian era and an uncut original sheet of this paper was on view.

In the account, Mr. Grigg mentioned that George Busk, a past Secretary of the Linnean Society and a President of The Royal Microscopical Society in 1849, had reported the use of an air pump for mounting in Canada balsam and told of the value in animal mounts of a fluid named 'Glycerine' the 'sweet principle of oils and fats' but regretted the growth of confervae and moulds after a time.

A 1750 *c.* solar microscope was used to project some contemporary ivory sliders on to the screen, the objects shown included a sheep tick, human flea, and louse, humming bird feathers and wood sections.

Manuscripts and Drawings.

Exhibited by the Royal Society.

1. Manuscripts and drawings of J. J. Scheuchzer's 'Descriptio Itineris Alpini'.

   Johann Jacob Scheuchzer, F.R.S. (1672–1733) made an extended tour of the Alps in 1703, 1704 and 1705 and his account of the journey and of his observations was subsequently published in 1708. The original manuscript and drawings were presented to the Royal Society by Scheuchzer.

2. Manuscripts and drawings on the Anatomy of Plants by Marcello Malpighi.

Marcello Malpighi, F.R.S. (1628–1694) sent the manuscript of his work on the Anatomy of Plants to the Royal Society in 1674 and the Society immediately licensed it to be printed. It was published in 1675 in London.

3. A volume of original water-colour drawings of plants by Richard Waller.

Richard Waller, F.R.S. (1650–1714) was for a time one of the Secretaries of the Royal Society. It is thought that he had business interests in the City of London, but he was a man of letters, a linguist and certainly a careful artist. He was particularly interested in zoology and botany.

4. A collection of water-colour drawings of plants.

These drawings had been in the possession of Philip Miller, F.R.S. (1691–1771). This is apparent from the fact that the names of the plants illustrated are in his hand. It is not known who painted most of them.

A book Herbarium made by Jacob Bobart the elder and his son (*c.* 1660-).

By S. Savage.

This interesting Herbarium was lent to the Linnean Society by the Public Librarian, Bedford, in the hope that it might be possible to discover its compilers. The Public Library, Bedford, had received it as part of a trust from the old Bedford Library founded in 1700.

The handwriting on the older labels agrees with that of Jacob Bobart the elder, and the corrections on the labels and other inscriptions are in the handwriting of Jacob Bobart the younger, examples of which are to be found in the Sherard MSS. at the Royal Society. (The former handwriting is confirmed by the labels of a book herbarium in the Department of Botany, British Museum, which are known to have been written by Bobart the elder.)

The arrangement of this herbarium is alphabetical; and seems to have some reference to the catalogues of the Oxford Gardens published in 1648 and 1658. At several places there is an attempt to classify a genus, which may have some connection with the younger Bobart's work in editing the third volume of Morison's *Historia*.

The plants are without localities, and include garden plants. At the end of the volume is what appears to be a sketch-plan in pencil of the Oxford Botanic Garden.

Cast of Medallion portrait of Linnaeus by Tobias Sergel, made by order of Queen Lovisa Ulrika for the museum at Drottningholm.

By S. Savage.

The mould was found in a manor house in the province of Skåne a few years ago; and the cast exhibited is a present from the Linnaean Museum of the Svenska Linné-sällskapet, the present owner of the mould.

The medallion was made by Sergel in 1766; and it is interesting to compare it with the Sergel medallion on the tomb in Uppsala Cathedral, executed in 1794, from which it is obvious that Inlander's medallion has influenced the sculptor.

Johan Tobias Sergel was Sweden's greatest sculptor. In Acerbi's *Travels through Sweden, Finland and Lapland . . . in 1798 and 1799*, Vol. I, p. 159 is some account of him.

The Linnean Society already possesses a contemporary cast of this medallion, presented by Sir Joseph Banks on 2 January 1792. It has suffered from renovation, having been broken to pieces some years ago and renovated by a modern picture dealer.

Developmental adaptations of the primitive anuran genera, Leiopelma and Ascaphus.

By N. G. Stephenson.

Leiopelma (New Zealand) and *Ascaphus* (Northwestern United States), have been placed by G. K. Noble (1927) in the Family Leiopelmidae (Suborder Amphicoela), as the most primitive of living frogs. The two genera, however, are very different in their developmental adaptations. *Leiopelma* undergoes intracapsular development on land, whereas the eggs of *Ascaphus* are laid in water and hatch into tadpoles adapted to the conditions of torrential mountain brooks. Observations and illustrative material of *Leiopelma* result from field-work in New Zealand extending over several years. Tadpoles of *Ascaphus* were forwarded from Mt. Rainier National Park, Pierce County, Washington.

Recent water-colour drawings of British Wild Flowers.

Exhibited by The Medici Society.

Recent water-colour drawings of wild flowers native in Great Britain were exhibited by The Medici Society Ltd., Print and Book Publishers. The drawings included works by Miss Heather Child, Miss H. D. Garside, Stella Ross-Craig, and Miss Lillian Snelling.

Water-colour drawing of Fungi.

By Miss H. D. Garside.

The species depicted in this drawing are *Armillaria mellea* (Vahl) Fr., *Boletus sanguineus* (With.) Quél., *Phallus impudicus* (Linn.) Pers., *Amanita muscaria* (Linn.) Fr., *Polyporus betulinus* (Bull.) Fr., and *Calocera viscosa* (Pers.) Fr.

PROCEEDINGS OF THE GENERAL MEETING ON 11 March 1948

Professor G. R. de Beer, F.R.S., President, in the Chair.

The Proceedings of the General Meeting held on Thursday, 26 February 1948, having been circulated, were taken as read and confirmed.

The President announced that The Pilgrim Trust had made a most generous grant to the Society; and moved the following resolution, which was carried with acclamation,

> The President, Council and Fellows of The Linnean Society of London in General Meeting assembled desire to express to the Trustees of the Pilgrim Trust most grateful thanks for their donation of £2,500 to form the nucleus of a Fund of £10,000 for the restoration and augmentation of the Library. The Fund will greatly enhance the value of the Library which has now been used by naturalists for 160 years and will enable a much wider circle to derive greater advantages from its valuable collections.
>
> This improvement of the Library will remain as another example of the generous policy of the Pilgrim Trust.

The following were thanked for gifts made to the Library since the last meeting :—The Pilgrim Trust, Mr. P. Helveg Jespersen, Mr. H. G. Maurice, Miss E. F. Noel, Mr. W. R. Price and Mrs. Beatrice Stuart.

The following Fellow signed the Obligation in the Roll and Charter Book, and was Admitted a Fellow :—Dr. L. Harrison Matthews.

In accordance with Chap. 10, Sect. 8 of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer's accounts for 1947–48 :—

Representing the Council : Mr. A. H. G. Alston.
Mr. H. W. Parker.

Representing the Fellows : Mr. I. H. Burkill.
Miss E. M. Wakefield.

Taken as read for the first time certificates of recommendation of candidates for election to Fellowship, whose names have been published in the Agenda, for ballot on the 29 April 1948.

Read for the first time certificates of recommendation for election to Foreign Membership, in favour of Professor Louis Fage, Académie des Sciences, Paris, and Professor August Weberbauer, Universidad de San Marcos, Lima, Peru.

The President reported the death of Dr. Bernard S. Dyer, Fellow of the Society.

It was announced that the General Meeting already arranged for 1 April had been postponed until 22 April ; and that an extra General Meeting had been fixed for 13 May, for a symposium on the homing of birds.

The President reminded Fellows that they were entitled to send in by the 21 April recommendations for the election of Officers and new Members of Council.

The following communications were read and discussed :—

Dr. Malcolm Smith. A living Newt (*Triturus vulgaris*) exhibiting neoteny. (Exhibit.) (Discussed by the President, Mr. J. Chear, Dr. H. A. Baylis, Mr. J. Proskauer and Mr. F. C. Grigg ; Dr. Malcolm Smith replied.)

Survey of the Outer Hebrides.—Speakers :—

Miss M. S. Campbell. Plant Collecting in the Outer Isles with particular reference to some unusual habitats.

Dr. James W. Campbell. Outer Hebridean Bird life.—The Breeding of the Common Heron (*Ardea cinerea cinerea* L.) illustrating changes in status and habitat.

Abstract.—

Man's indirect influence—the results of his husbandry, drainage schemes, and everyday activities—has played an important part on the status and distribution of birds in the Outer Hebrides. One of the most important factors has been the movement of the human population which has taken place during the last 100-150 years. This has been due, largely, to the struggle that has taken place for shares in the good agricultural land which, in the Uists is limited in extent and confined almost entirely to a narrow belt

on the Atlantic coast. About 1840, evictions took place in the Islands, many crofters or small-holders being removed from the belt of valuable agricultural land, and their holdings incorporated in large farms. Many of these displaced persons emigrated, but others were compelled to settle on land of poor agricultural worth, on the east coast and lesser islets. This resulted in less disturbance where large farms replaced small crofts, but increasing human interference in the remote east coast areas which previously had been largely undisturbed. From 1900 until after the 1914–1918 war, the policy was reversed, the large farms being broken up into small-holdings, and unprofitable crofts on the east coast abandoned.

The decrease of human disturbance in the east coast areas has certainly been an important factor in the colonization of this area, for breeding purposes, by the heron.

Prior to 1902 there was no record of this species breeding in the Outer Isles, but between 1915 and 1920, extensive colonization took place and there are now (1948) many breeding colonies. Even in the comparatively treeless Outer Hebrides, the heron show a preference for building in trees, so that nests are built most often in Scrub (Willow, Rowan, Aspen). Owing to extensive heather burnings carried out by man, scrub is confined to islets in freshwater lochs, to sides of ravines and to escarpments, where the bushes have escaped the fires owing to accidents of geography.

The presence of breeding herons exerts a marked and interesting change on the habitat in the vicinity of the nests. Within five years the scrub in which nests are built is completely destroyed. Long heather also suffers and is killed out. For a time there is a luxuriant ground vegetation of sorrel, chickweed and other plants, but eventually scrub and lush ' shade ' vegetation is replaced by rough grass. When the cover is completely exhausted, the site is abandoned by breeding herons.

The investigation of these colonies, where the nests are virtually at ground level, has produced some interesting data on the breeding biology of the heron.

Topographical films were shown of N. Uist, Harris and Lewis and some of the islands in the Sound of Harris and a short film of the flora in N. Uist.

(Discussed by the President, Mr. W. T. Stearn, Mr. Iolo A. Williams, Major Maxwell Knight, O.B.E. and Mr. A. J. Wilmott ; Miss Campbell and Dr. Campbell replied.)

The Meeting was then adjourned until Tuesday, 16 March 1948.

PROCEEDINGS OF THE ADJOURNED GENERAL MEETING ON Tuesday, 16 March 1948

Colonel F. C. Stern, O.B.E., M.C., and later, Dr. A. Tindell Hopwood, Vice-Presidents, in the Chair.

The following were thanked for gifts made to the Library since the last meeting :—Professor G. D. Hale Carpenter, M.B.E., Dr. Carlos Emmons Cummings and Dr. A. E. Porsild.

A Joint Discussion with the Systematics Association on ' The organization of Taxonomic Research ' was held, the principal speakers being Dr. E. Trewavas, Dr. J. W. Evans, Mr. E. Milne-Redhead and Dr. N. L. Bor, C.I.E. Other speakers were Dr. W. B. Turrill, Dr. A. F. Thomas, Dr. J. A. Freeman, Dr. R.

Melville, Prof. T. G. B. Osborn, Mr. G. J. Kerrich, Mr. J. Wyatt Smith, Mr. B. L. Burtt, Mr. G. I. Crawford, Dr. C. R. Metcalfe and Dr. A. Tindell Hopwood. [Printed in full, below.]

The Vice-President in the Chair expressed the thanks of the meeting to the contributors to the Discussion and to the Systematics Association for arranging the programme.

DISCUSSION ON THE ORGANIZATION OF TAXONOMIC RESEARCH

ETHELWYNN TREWAVAS: The systema naturae is to-day recognized to be a dynamic system and the approach to the study of taxonomy has expanded accordingly. Taxonomic research is now more than the arranging and naming of collections of dead animals and plants. It includes :—

(i) morphological work, involving the making and keeping arranged in accordance with modern knowledge of a large reference collection and library ;

(ii) field work ;

(iii) experimental work ;

(iv) genetics.

It is not the purpose here to enlarge on the necessity for all these techniques ; this is amply expounded in such books as ' The New Systematics ' (1940) and Mayr's ' Systematics and the origin of species ' (1942).

Work of the first category, museum work, once considered the whole of taxonomy, remains a basic and essential part of it, and such organization of taxonomic work as exists is centred round the large museums, in this country those at South Kensington and Kew.

If the country were in a period of economic expansion it would be pleasant and perhaps profitable to sketch a full-scale plan centred on these institutions. The museums would be staffed so that no major group would be without a specialist working on it. To the present building would be added laboratories for experimental work, well equipped and staffed. Funds would be provided so that adequate field work would be included in taxonomic research projects.

At present, however, no practical purpose could be served by planning on such a scale, and I propose to examine the ways in which the present set-up can best be used without waste of effort.

I hope I may be permitted to speak mainly in terms of the British Museum (Natural History), as being the institution I know best, although many of my remarks apply also to Kew.

First, is a national museum an institution for taxonomic research ? On the one hand we have those, including some professional biologists, who think its primary purpose is public education by means of exhibits and lectures. At the other extreme there are those who consider that it is there to house and curate and catalogue the national collections, and that such a task hardly calls for any research.

For a national museum, the care of the collections is an obligation that cannot be avoided. If in our poverty we must neglect part of our work, this one function must remain, because it is the only one that cannot be performed by any other institution. If during a period of acute emergency this can be interpreted as mere ' care and maintenance ', at any other time it means much more. Curating the natural history collections means keeping them in good condition ; adding to them so as to make them as complete a reference collection as possible ; arranging them in a natural classification according to modern knowledge and modern standards ; and indexing and cataloguing them. This is a task immensely beyond the capacity of the present staff.

No considerable collection arrives at the national museums the naming of which does not involve some research, throwing new light on the classification. Unless the results of each investigation of this kind are brought to publishable standard and published, the work involved is wasted. I think I speak for most curators, and for many of their most sympathetic advisers, when I say that the most satisfactory way to arrange curatorial work is to put away the greater part of the acquisitions, named as well as published work permits, and to spend research energies in revising one group at a time—a genus or a family. Such world revisions are undoubtedly the most valuable contribution a taxonomist can make to the advance of his science—or a curator to the arrangement of his collection.

Yet how difficult it is for a curator to plan his work in this way! Monographic work is almost impossible unless the curator is prepared to make it his hobby. And this he commonly does, working at home in the evenings and spending his holiday (no university vacation in length) at field work.

For a curator's duties are many. He is a public servant, and receives many enquiries, both from the lay public and from other zoologists, on the group in his charge. The making and upkeep of even the minimum of indexes necessary takes much time. For such work he has the assistance still of much too small a complement of ancillary staff.

A museum curator therefore, having taken the measure of his job, must decide what he can afford to neglect, must draw up a list of priorities. Priorities are largely determined by demand, and demand comes both from economic biology and from philosophical biology. It is obvious that a limited permanent staff cannot satisfy all the demands of this type. Hurried work will not suffice, for a single identification may determine the course of an experiment in applied biology, or may, in the hands of the zoogeographer or geologist set a continent rocking—in theory! Mistakes are bound to occur if the leaders of biological research projects assume that they may leave all their taxonomic work to the permanent staffs of museums.

A model research unit, in my view, is the Anti-locust Research Centre led by Dr. Uvarov. This unit is based in the Natural History Museum, and uses the Museum's collections and library. It includes, however, its own taxonomist, for the definition of locust species is basic to the whole control scheme. Its members are not only in constant touch with field workers, but some of them pay frequent visits to areas of infestation. This, of course, is not a unit for taxonomic research as such, but for applied biological research in which taxonomy is not divorced from other aspects of biology.

Another body, whose relationship with the museum seems to me excellent, is the Commonwealth Institute of Entomology. Only one of its functions is identification, but for this it employs its own taxonomists, whose work is intimately dove-tailed with that of the museum staff.

Such arrangements make it possible to use a rather meagre central organization in the most economical way. Another possible means of meeting an urgent demand for intensive work on one group is for the museum to co-opt workers for special projects. There is already some small provision for this, but it is not enough to attract people who require the prospect of a career.

I submit that the present arrangements for taxonomic research have in them the germs of a workable organization. To make it work well:

1. The permanent staffs of museums should include (*a*) enough well qualified scientists to ensure the carrying out of a reasonable amount of research work of the standard demanded by modern requirements and possibilities; (*b*) an ancillary staff capable of relieving the research staff of tasks of a more routine nature.

2. Opportunity should be given to qualified members of permanent staffs to do necessary field work, and to visit other museums to examine types and special collections.

3. Research projects which include taxonomic work should not rely entirely on the permanent staffs of museums for their identifications, but should set aside time and personnel for this purpose.

4. Biologists in all fields should take cognisance of the nature of taxonomic work and of the nature, limitations and possibilities of its present organization, so that its development may be advanced and supported by a body of informed opinion.

All these requirements are met in some degree already and are, I believe, well understood by those responsible for the central institutions ; their adoption as the policy of all interested in taxonomic work would strengthen its progress.

Dr. J. W. Evans : This contribution is based largely on notes prepared by Dr. T. H. C. Taylor, who was to have spoken to-day, but who is unable to be present. Dr. Taylor and I are on the staff of the Commonwealth Institute of Entomology, which has its headquarters at the Natural History Museum. On this account, and because we have ourselves done a certain amount of systematic work, we are familiar with its nature and aware of its significance. At the same time, we are both essentially applied entomologists, and have spent considerable periods in remote places, engaged in field work, and it is from the point of view of an applied entomologist that I am speaking on Dr. Taylor's behalf.

Every field entomologist is aware of the importance of systematic studies, and knows that they are essential for the background, or framework, of his own investigations. The following instance is a good example of how the field entomologist relies on the systematist for assistance. Several years ago, an injurious mealy-bug was recorded as a coffee pest in Kenya. It was submitted on various occasions to appropriate specialists for identification, who at different times gave it a different name. So long as the current name was used only in reports, the uncertain identity of the insect was not of great moment. Directly, however, the decision had been taken to control the pest by biological methods, its identity was of great importance, because of the associated clue as to its country of origin. At the time when it was decided to try biological control, the mealy-bug bore a name which implied that it was a native of Java. Accordingly a search was made in Java for parasites, and several were found. These were sent to Kenya, but failed to attack the coffee mealy-bug.

A re-examination of the systematic position of the insect led to the opinion that it was not after all identical with the Oriental species, but that it was probably an East African one, indigenous to the neighbouring territories of Uganda and Tanganyika. Parasites were subsequently procured from these countries, and their establishment in Kenya led to the control of the pest.

As by now, most field entomologists have assembled named references collections of the injurious insects that concern them, it might be supposed that their need for assistance from taxonomists no longer exists. This, however, is not the position, and they still rely on taxonomists for help in many directions. The principal services rendered by taxonomists to the field entomologist at the present time are :

(1) *The rapid identification of new introductions.*

Without this service the field entomologist would often be unable to decide whether he should attempt an immediate eradication campaign of a new insect, or whether its presence is of no significance.

(2) *A revision of difficult genera containing several species of economic importance.*

(3) *The identification of parasitic insects.*

Instances occur where field entomologists are aware that the names given to them by systematists are almost valueless. For example, there are those species which have developed physiological races without any evident accompanying morphological change, and cases of highly variable species of uncertain status. In order that these and many other taxonomic problems may receive satisfactory treatment, it is essential that field workers and systematists co-operate. This co-operation must proceed further than visits of the former to museums, and facilities must be provided for museum workers to travel to gain field experience. The benefits would be great, and real progress made, of inestimable practical value.

In conclusion, there remain three points which Dr. Taylor had intended to raise. The first concerns the need for increased efficiency of liaison services. It would seem that often, when an animal or a plant is submitted to a recognized centre for identification, none is supplied, on the grounds that there is no specialist available in the particular field concerned. Doubtless sometimes this is the true position, but there are probably other instances where, though a specialist may exist, his existence is unknown to the Bureau. It would be appreciated greatly by field workers if liaison centres were to take greater pains to keep themselves informed about the specialists in the various branches of the field they profess to cover.

The next point is that adequate recognition be given to the importance of curatorial services. In some colonies, while it may be recognized that the assembling of an insect collection may be part of the necessary functions of an entomologist, no recognition is given of the need for the regular maintenance of collections. Such a state of affairs will persist until it is generally accepted that curation is sometimes of almost equal importance to research.

Finally, there is the pressing need for more insect taxonomists. The fulfilment of this need depends primarily on two distinct factors. One is that the conditions of their employment be made more attractive, and by this more is implied than just increased remuneration. The other is that it be officially recognized that taxonomic studies are of basic importance to the solution of countless practical biological problems. Without recognition of the first factor, there will be no taxonomists available for posts, and without recognition of the second factor, there will be no additional posts available for potential taxonomists.

Mr. E. Milne-Redhead: In the few remarks which I am making this evening, I am confining myself to the flowering plants of tropical regions, although some of the points raised will undoubtedly have a wider application.

First, let me indicate the present position. The taxonomy of certain groups, including some of known economic importance, is in a reasonably satisfactory state. But that of the great majority of groups is either very incomplete, unnatural or out-of-date. For instance, the latest comprehensive treatments of such widespread genera as *Senecio* and *Euphorbia* are to be found in De Candolle's Prodromus, published in 1836 and 1862 respectively. In the last hundred years, taxonomists in most countries have worked mainly on the production of regional floras; in Germany alone was work concentrated on monographic lines. I fully realize the need for floras, but I do think the dangers of a geographically restricted treatment have not been fully realized. It is no uncommon occurrence to find a pan-tropical species answering to one name in India, to another in Africa and to yet a third in tropical America!

Monographic treatment of all groups should be the principal aim of

Taxonomic Research. Monographic treatment requires the specialist. No one Herbarium can have more than a strictly limited number of specialists, and on this account I would stress the need for the closest co-operation between National Herbaria, both British and Foreign, so that the specialist concerned may freely study the greatest possible number of specimens of his groups. Full use should be made of specialists in the preparation of regional floras.

In taxonomy a shortage of manpower is nothing new. A skill in taxonomy is only built up by years of accumulated experience. How wasteful it is then to use a skilled systematist for all the hundred and one routine curatorial duties in a herbarium! Yet this has been a common practice in Herbaria, due to the provision of an entirely inadequate number of ancillary staff, who, to make matters worse, may well be temporary and casual and quite unsuited to the tasks they are supposed to perform. If provision be made for an adequate number of permanent assistants it should be possible for the professional taxonomist to concentrate during the last 15 or 20 years of his career on major taxonomic research.

In addition to dealing with dried specimens of plants, the taxonomist should be familiar with the plant as a living organism. Whilst field work in a temperate region may be helpful in broadening the outlook of the taxonomist working on a tropical flora, I consider it an essential part of the training of such a taxonomist, that he should from time to time visit the tropics to collect plants and gain experience of the degrees of plasticity of a species under varying edaphic and climatic conditions. A herbarium should have sufficient scientific staff to enable one botanist at any time to be away in the field, without seriously dislocating the routine work.

Whilst taxonomists are able to assist the ecologist, the agricultural officer and the forest officer by the rapid and accurate determination of material, they should, on the other hand, be able to call upon these officers for help in settling some of their specific problems. In some territories such close co-operation is an actual reality, but in many others it is not so. I feel that co-operation between Herbaria at home and the respective Government Departments in the tropics should be strengthened, especially at the higher levels. I would like to see all ecologists, and any agricultural or forestry officers whose duties bring them into close contact with vegetational problems, attached to a large herbarium for a while after completion of their first tour of duty, so that they could learn the elements of herbarium methods and understand how and why material should be prepared and annotated. I gather that a start has been made in this direction so far as Forest Officers are concerned, and I would strongly advocate the wider application of such attachments.

If the time of the taxonomist at Home Institutions is not to be wasted by large numbers of routine determinations of common plants, there is a strong case for the maintenance of adequately staffed Regional Herbaria. These Herbaria should provide a prompt service for the determination of common and well-known species. Little-known or critical species would be forwarded to a Home Institution for examination and determination in due course. It is not intended that taxonomic research on any large scale should be carried out in Regional Herbaria, nor should type specimens be deposited in them to the exclusion of the National Herbaria. Facilities should be available for the exchange of staffs between Home and Regional Herbaria from time to time.

I feel that much more use might well be made of existing Botanical Gardens in the tropics. The Gardens should grow, under controlled conditions, plants from their own native flora. In co-operation with specialists at home, living collections of certain groups might be made, so that the value of supposed specific differences could be studied in individuals growing side by side. These Gardens should provide much information regarding the reactions of plants

to different edaphic conditions. Each Garden should have an adequate horticultural and scientific staff, the latter to include at least one taxonomist of wide outlook. In my opinion the establishment of Botanical Gardens in the savannah region of Africa should be a matter for early consideration.

From time to time scientific expeditions of one kind or another go into the tropics. Often they visit regions about the biology of which little if anything is known. I would suggest that the appointment to all such expeditions of a taxonomic botanist, or failing this, a trained botanical collector, should be considered. The cost of attaching an extra person to an expedition, the administration of which is already organized, is little, and the chance of his being able to obtain useful collections is great. A boundary commission, which of necessity moves slowly, gives a collector excellent opportunity to collect. Yet how seldom has the opportunity been taken in the past! I would also like to see a taxonomist or botanical collector attached to every ecological survey, so that the work of the ecologist may be based on well prepared and annotated specimens rather than on the scraps which the ecologist, I regret to say, so often produces, and which the taxonomist may well be unable to name.

In these ways, the steady flow of well preserved and annotated material into the herbaria of the major botanical institutions would be maintained, the material on which the specialist is working would constantly be increased and enriched, and taxonomic research would suffer fewer setbacks due to imperfect specimens and absence of field notes, as so frequently occurs to-day.

Dr. N. L. Bor: It is interesting to trace the history of the organization of taxonomic research in India because it throws into relief some aspects of the difficulties to be met in that country and also in the colonies—difficulties which are not always apparent in Europe or America.

Looking back over the past 150 years of botanical research in India, this period falls easily into three equal divisions. The first 50 years of the 19th century were a period of intense activity among British botanists. Anyone who has had anything to do with Indian Botany will be familiar with the following names:—Roxburgh, Griffith, Wallich, Buchanan-Hamilton, Wight, Arnott, Royle, Lindley, J. D. Hooker, Stocks, Munro, Falconer, to mention but a few of the earlier botanists. Incidentally, it is surprising how many of these earlier botanists were Doctors of Medicine. One is irresistably driven to the conclusion that they were better botanists than doctors, and, having disposed of their patients in the shortest possible time, were then free to devote their efforts entirely to the pursuit of botany.

However that may be, these men put together enormous collections and covered very wide areas, so that within a comparatively short space of time a great deal was known of India and its flora.

The good work of the earlier botanists was carried on into the second half of the century and came to a climax in 1892 when the Botanical Survey of India was created with the avowed purpose of co-ordinating all botanical exploration and research in India. The original team was a strong one, with Sir George King as its head and with Duthie at Saharanpur, Cooke in Bombay and Lawson in Madras. A tremendous amount of work was accomplished by these men and their collectors and there was no slackening of the pace when Sir David Prain succeeded King as Director. Explorations were carried out and the results were published without loss of time. In fact, these may be termed the halcyon days of Indian Botany.

The turn of the century brought a change for the worse. Duthie retired from Saharanpur in 1903, and his post was abolished, the herbarium going to the Forest Department at Dehra Dun. A process of decay now set in and the other departments gradually petered out, and the only explorations of distinction in the last period were those of Wright Smith in Sikkim and by Burkill in 1911–12 in the Abor Hills of Assam.

The Director of the Botanic Gardens in Calcutta was *ex officio* Director of the Botanical Survey of India, but since all funds were withheld the service was completely crippled. The post of Director, itself, was abolished in 1937.

Such is the history of botanical research in India, which started with such high promise and such great achievement and petered out so miserably at the end. There is now no co-ordinating authority in India, neither has there been one for many years. Research goes on fitfully in centres widely separated from one another and without any co-operation between them.

I expect that some will be asking themselves what all this has to do with the subject for this evening's discussion, since what I have said so far seems to relate to the 'Disorganization of Taxonomic Research' rather than its organization. It has been necessary because the points I wish to make are peculiar to our overseas possessions, or, at least, I hope they are.

It is quite obvious that organization and expansion of any type of research costs money. In democratic countries the provision of funds is subject to the votes of individuals and to the scrutiny of officials who are themselves only too rarely men of science.

It is not that those of us who controlled scientific institutions in India did not know what should be done—we did know that—the difficulty was to persuade those who control the purse-strings to disgorge the funds necessary not only for maintenance of current research but for desirable expansion.

In India or in any colony where there is a legislature composed of the elected representatives of the people, the department in which the most interest is taken is the Finance Department, *i.e.* the Department from which all blessings flow. Any expenditure on what are euphemistically called 'The Nation building Departments' is approved without question but any expenditure on matters such as research are subject to very close scrutiny.

During the past 50 years in India there have been financial crises from time to time and on each occasion savings have been made at the expense of research departments. In my own province, Assam, the Cinderella of India's provinces, the favourite object for annihilation was the research officer of the Forest Department. This officer, a member of the India Forest Service, is the individual in whose hands is all the scientific work of the department, a good deal of it long-time research. He controls several hundred experimental plots, sample plots and so on. With his disappearance also goes continuity in research and the work already done is valueless. The process has happened on three occasions in the last quarter of a century. The research which should have been completed long ago has so far yielded meagre or no results. Other favourite items for savings are equipment and books, maintenance, staff, and so forth.

It will be readily realized, therefore, that in such countries any advancement towards an ideal or even, in some cases, steady progress, is contingent upon the prosperity of the country and also to the extent to which public opinion has been educated. Public opinion, or lack of it, must not take all the blame for the restrictions placed upon taxonomic research in India. One of the greatest obstacles to the expansion of research was the almost incredible ignorance of administrative officials of the value of research.

Once, during a campaign for savings, the branch officers of the Forest Research Institute were asked to justify their posts by the yardstick of the value in rupees their research meant to the Government of India. As a tough mental exercise this can be recommended to any working biologist.

The worst feature of the abolition of the Botanical Survey of India is that there are no young systematists coming along. If there are no jobs to be filled the subject will not be taught in schools or universities. There are no professors at the larger Universities who are taxonomists, and while there is no dearth of cytologists, palaeobotanists and embryologists and so forth, systematy is

neglected. The result of this is that a volume of research on plants from various angles is being poured out without the systematic identity of the plant being adequately established.

The Flora of British India, magnificent achievement though it is, is still regarded by many in India as the ultimate authority on the names and identities of Indian plants. In a recent paper on fossil leaves found in the Pleistocene beds of Kashmir, reference is made to the ivy, the *Hedera helix* of Linnaeus and this is followed by a discussion which covers the distribution of the ivy as this species was known 50 years ago. The author does not appear to be aware that the Himalayan species of ivy is specifically distinct from the European species, and that therefore we are left in pleasing uncertainty as to whether the fossil leaves are those of the European *Hedera helix* or of the composite *Hedera helix* or whether it is actually *Hedera nepalensis*.

Now, what of the future? Well, there are signs that we may hope. The present Government of India has decided to revive the Botanical Survey of India and have advertised the post of Director. It is upon the choice of this individual that the fortunes of the survey will depend. If the Government of India can get the right type of scientist the future of taxonomic research in India will be bright, but if they fail to do so we may expect little or no progress towards a sane organization of taxonomic research in that country.

I am sure that it is the hope of all of us that the new botanical survey of India will start modestly and go from strength to strength. If, however, it is to be subject to the fluctuation of prosperity and depression, we may expect a repetition of the fate of its predecessor.

Dr. W. B. Turrill stated that he fully agreed with the general trend of the four papers which clearly set forth the needs of increased numbers of posts for trained taxonomists. It was, however, essential to emphasize one matter which had been only briefly and rather indirectly referred to by the speakers, namely, the extreme difficulty at the present time of obtaining trained taxonomists for posts now vacant. It was difficult to urge for the creation of new posts when posts already authorized could not be filled with suitable candidates. Proper training in the methods and principles of taxonomy in the departments of botany of the universities was an urgent matter and basic to much of what had been so well stated by the previous speakers. Every encouragement should be given to the Linnean Society and the Systematics Association in their attempts both to broaden the contents of and outlook on taxonomy and to demand for it a fair place in botanical education.

Dr. A. S. Thomas explained the difficulties of collecting botanical specimens in the colonies, of the pressure of other work, of restricted transport facilities, and the lack of official encouragement. He cited the case of the Karamoja district in Uganda, a large area from which there were no specimens available and in which he first collected while on local leave; three years later he was sent there to make a report, but could have given the names of few plants if he had not previously visited the district at his own expense.

He agreed with Mr. Milne-Redhead about the value of cultivating wild plants in botanic gardens, for that helped both taxonomic and ecological studies. Taxonomic studies were an essential preliminary to ecology and economic botany, for it was difficult to ascertain the correct names of some of the most common wild plants, and even of some of the most widespread cultivated plants.

After reference had been made to the difficulty and expense of arranging collecting expeditions from England, he suggested that if institutions in this country wanted material, they might obtain it more cheaply by offering to pay the expenses for people in the colonies to collect while on local leave.

Dr. R. MELVILLE: About a year ago the need arose to examine the pollen of the Onion, *Allium cepa*, and on visiting the Herbarium, no flowering material could be found either from the British Isles or from Europe of this common economic plant. Eventually pollen was obtained from a specimen from Kashmir, but the species is very poorly represented in the Kew herbarium. It is impossible to make a critical study of the Onion in our national herbaria; material of wild or subspontaneous forms is scanty and the numerous cultivated forms are for the most part absent. The example of the Onion is typical of existing conditions; with few exceptions crop plants, such as peas, beans, carrots and turnips, and fruit trees, such as apples, plums and cherries, are very poorly represented in our national herbaria in spite of their importance to mankind.

It is highly desirable that this unsatisfactory state of affairs should be remedied. Adequate herbarium material should be obtained of all varieties of crop plants in cultivation and examples of at least the most important forms developed in any plant-breeding programme or employed in any major research project should be filed in a national herbarium. At the same time, an effort should be made to obtain a full range of the species related to plants of economic importance. Many of these could and should be kept in cultivation in tropical and subtropical botanic gardens, as suggested by other speakers. Linking up with the need for perpetuating and possibly expanding such botanic gardens is the desirability of setting aside as nature reserves fairly extensive tracts of land to preserve the allies of existing and potential crop plants for use in future plant-breeding work.

Mr. G. J. KERRICH, taking up Dr. Turrill's question as to why young people were not undertaking taxonomic studies at the present time, agreed that this was not due entirely to the unfavourable war period. In his student days at Cambridge, there was quite a number of young men with a good grounding in the systematics of various groups of British insects. But after the financial crisis there had been a cutting down; and then at one time the British Museum was believed to have had a policy of not appointing those with previous systematic experience. Why, then, should a young person devote himself to systematics, when the study of other aspects of biology was so much more likely to lead to a desired appointment? There must be provided a reasonable prospect of a satisfactory job for those who made good in the subject.

On the teaching side, botanists were in the more favourable position; for the systematics of British plants was suitable for class-work, while in such a group as the insects, student teaching could seldom be carried beyond the recognition of the main families. There should be working taxonomists in university departments, able to encourage and assist students in such systematic work as they could do in their spare time.

Mr. B. L. BURTT: The need for ancillary staff, already emphasized in Mr. Milne-Redhead's communication, is particularly urgent in libraries. Taxonomists are spending a great deal of time on bibliographical work because their institutions' libraries are inadequately staffed. Further, if we to-day ask ourselves whether we are co-ordinating our taxonomic publications in such a way as to cause the minimum of bibliographical work to our successors, the answer can only be negative.

The discussion has underlined the need for understanding between the taxonomist at home and the field-workers, but chiefly from the colonial point of view. The worker on temperate floras needs liaison with field-workers in countries outside the British Empire, and in this sphere a drive by the Systematics Association to enrol foreign members and make known its views overseas might yield good results.

Mr. G. I. CRAWFORD spoke of two aspects of the organization of Taxonomic Research. The first was the danger of the taxonomist being isolated, and being regarded, and regarding himself, not as a biologist but as a man apart, who curated collections, named other people's specimens, and wrote systematic monographs. The second was the question of prestige. In his undergraduate days taxonomy was regarded as not being intellectually respectable. Nowadays he thought University biologists were more inclined to respect taxonomic workers, and there seemed a real opportunity for taxonomists once more to take a proper place among biologists.

Dr. C. R. METCALFE said that, when he had visited the British Mandated Cameroons in 1937 in company with Dr. J. Hutchinson, the once famous botanic gardens at Victoria were in a very neglected condition owing to lack of staff and funds. The decay of these and other tropical botanic gardens was not only an impediment to the advance of systematic botany but a serious loss to botanical science in general. It was also pointed out that administrative officers in Nigeria are constantly travelling in remote districts of which the botany is not well known. It was suggested that some of these officers might welcome the companionship of a botanist on their travels, especially in regions where they are unlikely to meet other Europeans. An arrangement of this kind would save expense, and might well operate to the mutual advantage of all concerned. Referring to the remarks of a previous speaker who had drawn attention to the difficulty of identifying sterile herbarium specimens, it was suggested that more use might be made of the anatomical method in dealing with material of this type. The large collection of microscope slides which had been made at Kew had already proved to be a very useful aid in establishing the family or genus of herbarium specimens which were not accompanied by flowers or fruits. Collectors of herbarium specimens could assist this work by preserving, in a liquid medium, small portions of young stems and leaves from the same plants. The preserved material could then be forwarded to a centre where it could be examined anatomically.

Dr. A. TINDELL HOPWOOD thought that the present shortage of taxonomers had arisen because of over-emphasis on the experimental side of biology during the last two or three decades. He suggested that a thorough grounding in gross morphology is the best training for taxonomy, and that once a sound foundation has been laid, it is not unreasonable to expect the student, with judicious guidance, to fill in the details for himself.

OBITUARIES

Frederick Harry Baker was born in 1865 and passed away on 6 January 1946. He is survived by his widow, son and daughter. He practised as a dentist at Richmond, a suburb of Melbourne. He was very quiet and unassuming. His scientific interests lay in microscopy and he had an exceedingly good range of microscopic equipment; and was particularly interested in differential staining, especially with strongly contrasting colours. He was a Fellow of the Royal Microscopical Society; and was elected a Fellow of the Linnean Society on 6 April 1893. R. T. PATTON.

The modest presence of the late Dr. **Emily M. Berridge** (1872–1947) has been among us these many years and her characteristic diffidence, her quick smile and her steadfastness and alertness of mind will long be remembered by those of us who knew her.

Dr. Berridge was elected a Fellow of the Linnean Society so long ago as 2 March 1905, and as the first women Fellows were admitted only in the previous January, she was one of the early women members. She was, too, among the first women to read a paper before the Fellows of the Society, for it fell to her lot on 16 November 1905, as a joint author with Dr. Margaret Benson and a fellow-graduate of Royal Holloway College, Miss Elizabeth Sanday, to read their paper on the embryology of the Amentiferae. In a letter from Dr. Benson to Miss Berridge on 4 August 1905, we read : ' Dr. Scott says we can decide in October who had best read the paper, I thought that you had best, as the new matter is entirely yours ', and later, we read : ' We must do it really effectively as I don't think even Dr. Scott a bit realises what an interesting piece of work it is '.

Emily Mary Berridge was born on 20 February 1872, at Bromley, Kent, the eldest of three daughters of Harriet and George William Berridge, who was a member and examiner for the Institute of Actuaries. Mr. Berridge took a keen interest in the scientific education of his daughters, and excited and entertained them with his experiments, among them an electrical machine, and it was their great joy to mount an insulated stool and see their hair stand on end. Emily had especial attention, perhaps because of her extreme shyness, and she was later encouraged by her fifth-form mistress, Miss Arnold, at Dulwich High School, to take up a scientific career. In October 1891 she entered Bedford College, where she matriculated and studied for three years. Thence she passed with an entrance scholarship to the Royal Holloway College, and in 1898 she took a B.Sc. (Ext. Lond.) degree with honours in Physics, and wrote the Driver Prize essay in Botany. In the previous year she had gained the Driver Prize in Physics. After a break of two years, teaching in York, she returned to Botany, really her first love as a girl, and with much encouragement from Dr. Benson and Miss Ethel Sargant, she was launched into botanical research. She worked at first at her home, Dunton Lodge, Beckenham, Kent, trying to build up a laboratory, but the need for more scientific equipment led her to register as a research student at University College, London, in 1906, and at the Imperial College of Science in 1910. During that time and up to the outbreak of war, she published eleven papers, mostly in the *Annals of Botany* and the *New Phytologist*. These papers show the influence of her old teacher and friend, Dr. Benson, and Dr. Berridge always spoke with gratitude of the encouragement she received from her. In 1914 she was granted the D.Sc. (Ext. Lond.) degree.

The trend of her researches was then changed entirely by the war. From January 1916, for nearly three years, she worked in the Thompson Yates Laboratory, University of Liverpool, under the direction of Dr. Ernest Glynn, on agglutinations to determine and identify the fever bacteria carried by soldiers arriving in Liverpool from Alexandria, in particular the dysentery bacilli. A fellow worker has testified to her conscientious and constant work there. This was brought to an end by a severe illness, but in the session 1919–1920 we find her at work again, this time in the Department of Bacteriology, Imperial College of Science, South Kensington, under Dr. Sidney Paine. Her chosen subject now was the physiology and pathogenicity of plant disease bacteria, and it was her own idea to apply a method of acid agglutination used in Liverpool for the identification of dysentery bacilli to the separation and identification of plant pathogenic bacteria. Her careful and original researches are recorded for the most part in the *Annals of Applied Biology* 1921–1930. She had joined the Association of Applied Biologists in 1920, and was a member for eighteen years. From the beginning of the century she had been a member of the British Association, and had attended many meetings, the most exciting being that in Australia in 1914, with the perilous return to Britain via the Panama Canal, arriving New Year's Day 1915.

Not only did Dr. Berridge carry out research herself but she gave generously of her time, thought and money to young post-graduates just starting such work. About 1909 she warmly embraced Miss Ethel Sargant's idea of inaugurating a research laboratory at Bedford College. Dr. Ethel Miles Thomas became Keeper and Dr. Berridge Treasurer. Their efforts to encourage research were later resolved into the Botanical Research Fund, to the beneficial use of which Dr. Berridge brought all her wisdom, experience and keen interest until the day of her death. The extent of her generosity, however, will never be known, for her gifts were many and were made mostly anonymously. She worked in a number of laboratories and had many associations, but she had perhaps a special feeling for the Royal Holloway College, where she had first been initiated into botanical research, and in her lifetime she gave to its botanical department a microscope, a microtome and a telescope with a three-inch objective ; at her death she bequeathed her research microscope.

Dr. Berridge was not without ambition, but it was never for self-glory : rather to have accomplished something in life. At one time she set herself to write a paper every year. About her own work, however, she was shy and diffident, and so truly humble that only those who worked with her knew how good it was ; just as only those who served with her on research committees knew of her quick grasp of essentials, her sound judgment and unassailable integrity of mind and purpose.

Glaucoma, with the loss of an eye, put a stop in 1938 to work with the microscope. This cross she bore patiently, working as much as she could in her garden which was her lifelong hobby. She was a member of the Royal Horticultural Society for many years. In early days she painted charming little water-colour sketches.

She died on 8 October 1947, in her 76th year, of heart failure. And so passed a true gentlewoman, one of that early band of men and women of leisure, who devoted their lives to science, not for personal reward, but for the happiness of helping to unfold its growing wonders. E. M. Blackwell.

Pierre-Augustin Clément Dangeard, né à Segrie (Sarthe) le 23 Novembre 1862, est décédé dans cette même localité, sur la propriété familiale, le 10 Novembre 1947. Issu d'une lignée de cultivateurs, il en a gardé l'empreinte. Ayant dès son jeune âge manifesté le goût de l'étude, il était reçu, à l'âge de 16 ans, à l'École Normale Primaire d'Alençon, et, trois ans plus tard, devenait ainsi instituteur adjoint à l'école du petit bourg de Chanu (Orne). Encouragé par le prêtre de l'endroit, il y preparait le baccalauréat es sciences, puis la licence. Remarqué alors par le professeur de Botanique de la Faculté des Sciences de Caen, Morière, il entrait dans cette faculté, en qualité de préparateur (1884) et bientôtde chef de travaux (1886).

Il travaillait avec ardeur et de façon autonome, de préférence sur les organismes inférieurs, qui peuplent les mares, Protozoaires et Algues Inférieures, souvent difficiles à intégrer dans l'un ou l'autre des deux lignes organiques, sans négliger pour cela les plantes supérieures. Il avait une grande indépendance d'esprit et se trouvait ainsi bientôt en conflit avec son nouveau chef de service, Lignier (élève d'E. G. Bertrand et successeur de Morière à Caen). La mesure de cet esprit d'indépendance se manifeste dans le fait qu'en 1887, ce jeune travailleur de 25 ans, isolé, fonde pour publier ses recherches, un recueil, *Le Botaniste*, dont il devait paraître 31 volumes. Dans l'*Avant Propos* du premier fascicule il déclare : ' J'aurais sous la main un organe qui permette de soutenir mes idées, de les défendre, d'avoir une action directive contre tout théorie que me paraîtrait fausse '. Il a été dans toute la force du terme, un ' self-made man '. En 1886 il avait soutenu sa thèse de doctorat (*Recherches sur les organismes inférieurs*), à laquelle l'Académie des Sciences accordait le prix Desmazières. En 1891 il devenait maître de conférences (assistant-professor) puis, en 1894, à 32 ans,

professeur titulaire de Botanique à la Faculté de Poitiers, qu'il quitta en 1908 pour celle de Paris, où'il devait succéder, en 1924, à G. Bonnier dans la chaire de Botanique Générale.

Ses travaux avaient attiré dès le début l'attention de l'éminent algologue, Ed. Bornet. En 1905 il recevait de l'Académie des Sciences le grand prix des Sciences Physiques pour son mémoire, *Recherches sur le développement du périthèces des Ascomycètes*. Il était élu, le 21 Mai 1917, membre de l'Académie dans la section de Botanique.

Sa longue carrière a été un effort ininterrompu et ardent, s'exercant sur des objets très variés, mais avant tout orienté vers l'étude de la structure et de la reproduction des organismes inférieurs, à la limite des deux règnes, les Protistes, vers celles des Algues et des Champignons et vers l'étude de la cellule. Cette œuvre, contenue surtout dans les volumes du *Botaniste*, est considérable et on ne saurait envisager d'en faire ici l'inventaire. On rappellera seulement qu'on doit à Dangeard la connaissance précise de nombreux Protistes, l'analyse de nombreux faits de parasitisme et de symbiose, et, par dessus tout, qu'on lui doit les données fondamentales sur la sexualité chez les Champignons, Ascomycètes et Basidiomycètes. Il a en effet, le premier, analysé la succession des phases qui aboutissent à la réalisation de l'asque et de la baside et découvert les processus de fécondation qui en sont à la base.

La cytologie végétale, et la physiologie cellulaire (celle de la chlorophylle en particulier) ont été aussi des domaines préférés de l'activité de Dangeard. Dans la cellule il s'est appesanti surtout sur le vacuome, précisant la nature de son contenu et de ses dérivés, discutant ses rapports avec les mitochondries et les plastes. Il a, chemin faisant, formé de nombreux élèves et est resté actif jusqua'à un âge très avancé. Il y a trois ans il s'était rétiré definitivement sur sa propriété natale de Segrie. C'était un travailleur infatigable, un observateur habile et patient, un esprit original et généralisateur, tenant énergetiquement à ses idées et qui laisse une œuvre à la fois vaste et solide, dont la valeur a été reconnue, hors de France et qui, en particulier avait été bien comprise en Angleterre, où elle a reçu des témoignages d'éminente estime.

MAURICE CAULLERY.

[Professor P. A. C. Dangeard was elected a Foreign Member of the Linnean Society of London in 1935. The University of Cambridge bestowed the Doctorate of Science on him in 1931.]

Bernard Shirley Dyer (1856–1948) died on 12 February 1948, being in his ninety-second year. He was a Londoner by birth and received his early education at the City of London School, where he was introduced to the study of chemistry, including practical laboratory work, which was then available at that school alone of all the schools in London. Later on he studied at King's College, the Royal College of Science and the College of the Pharmaceutical Society. At the last named he attended the course in Botany and Materia Medica (1875) conducted by Professor Bentley and at its close was awarded the sessional certificate of merit, thus indicating his aptitude for botanical work. He graduated B.Sc. (London) in 1886 and during the next year, at the early age of twenty-one, he opened a laboratory at 17 Great Tower Street, London, where he continued to practice as an Analytical and Consulting Chemist until 1941, when the laboratory was completely destroyed during the blitz. Dyer was a foundation member of the Society of Public Analysts and was analyst for many counties, county boroughs and boroughs. His botanical interest was mainly centred upon the chemistry of the soil in relation to plant life and he did much original work in connection with the experimental plots at Rothamsted, studying the effects of fertilizers upon the growth of barley and wheat. The results of his early experiments at Rothamsted upon the availability

of phosphatic fertilizers were communicated to the Chemical Society and published in its Journal in 1894. The value of this work was recognized by the University of London, which conferred upon Dyer the degree of D.Sc. for this investigation. The study of soils and manures continued to be a major interest throughout his life and he published several books and papers dealing with these subjects.

Bernard Dyer was an active member of the Society of Public Analysts and was President for 1897–1898; he was also Vice-President of the Institute of Chemistry for 1908–1910 and Chairman of the London Section of the Society of Chemical Industry in 1923 and 1924; he was elected a Fellow of the Linnean Society in 1887. His many friends have spoken of his kindly disposition and of his readiness to help others who sought his assistance. I myself well remember, when still a student of analytical chemistry, asking for information about a process of analysis which I did not properly understand, and Dyer immediately gave me the details and sent me to one of his assistants so that I could actually carry out the experiment under his supervision.

Bernard Dyer has enriched the science of Botany by his study of soils in relation to plant life and leaves behind him a grateful remembrance of his kindly personality in the hearts of his friends. T. E. Wallis.

Edith Isabel Grindley, who died at Brockenhurst on 20 March 1948, was elected a Fellow in 1924, and was also a member of other scientific societies. From girlhood she had taken a keen interest in Botany and Ornithology and had continued her observations and studies to the end. Of late years she had specialized in Bryology. She had also spent much time on Biblical studies and the languages that contribute to that study, the classical and Hebrew, Syriac and Arabic. The last she was reading within a few hours of her death. She had done a good deal of teaching by correspondence on these subjects and had been awarded a medal for an essay on the period between the Old and New Testaments. H. E. Grindley.

Ben Wells was born on 15 March 1900, the only son of William and Clara Wells, and grandson of the founder of the well-known business which was originally concerned with the commercial cultivation of Chrysanthemums. He was educated at Reigate Grammar School and, being strongly attracted by the sea, became apprenticed to the Merchant Navy in 1917; he served with the Royal Navy until 1921 when he returned to Merstham to take part in the work of the Nursery, which now included Herbaceous and Alpine Plants as well as Chrysanthemums. After his father's death in 1933 he spent some years in reorganizing the business and was responsible for the introduction of the new race of hardy Chrysanthemums, the Koreans, of which he raised a number of varieties. He was beginning systematic work on hybridization, in which he was much interested, when the war came; in September 1939 he joined the Royal Artillery, serving with the Light Anti-aircraft unit. In 1942, having attained the rank of Lieutenant-Colonel, he was appointed Officer Commanding Troops and took troops to Algiers for the second African landing. He called at Gibraltar on 26 November and on 1 December 1942 was diverted from the convoy to America; thereafter he was reported 'missing'. His death was officially presumed in 1947. He leaves a widow, who continues to carry on the business, and three daughters. He was elected a Fellow of the Society in 1936. Vera Higgins.

[Part 1, pp. 1–72, *published* 26 *November* 1948.]

THE SYSTEMATICS ASSOCIATION

Annual Report VI. (1946–47).

The fifth 'Annual' Report covering the years 1942–46 was adopted at the Annual General Meeting held on 8 May 1946 and was published in the *Proceedings of the Linnean Society* 1944–45, Part 3, 29 November 1946. At this Annual General Meeting resolutions were passed instructing the Council to investigate a proposal to change the name of the Association and to draw up a set of rules. Action was taken accordingly and a special General Meeting held on 5 October 1946 accepted the Council's proposals; copies of the Rules, incorporating the amended title, have been circulated to members.

The October General Meeting was preceded by a series of demonstrations, discussions and exhibits dealing with Modern Plant Systematics, arranged by the Director and staff of the Royal Botanic Gardens, Kew. This meeting was reported in *Nature*, 1946, **158**, 19 October, pp. 535–539 and copies of the article have been distributed to members.

During the year the Association affiliated with the Biological Council, which has as its objects the attainment of a higher degree of co-ordination between the activities of societies interested in biology, by the dissemination of information about meetings and in other ways. The agreement with the Linnean Society has been prolonged for a further period of twelve months.

There has been a resumption of activities by the Committees as follows:—

Handbooks (convener Dr. B. M. Hobby). A conference was convened by the Association on 30 May 1946, which was attended by representatives of twelve other bodies concerned with, or interested in, the production of handbooks, or similar publications, dealing with the British Fauna and Flora. The conference unanimously agreed that there was need of a 'Fauna et Flora Britannica' in a series of volumes, according uniform treatment to each group so far as the state of knowledge of the groups permitted. Existing and projected schemes were considered in relation to this ideal. Great lack of uniformity was revealed and it also became clear that, although there was some overlapping, if all the schemes reached fruition there would still remain a considerable number of large gaps. It was therefore resolved that the Council of the Systematics Association should be asked to clear the ground, ready for action, by making recommendations regarding the ideal of a handbook, the groups most in need of handbooks, the number of volumes or parts that would be required for a complete 'Fauna et Flora', or, alternatively to fill the major gaps, and methods of securing authors and publication. These tasks have been entrusted to the Handbooks Committee.

Publications. At a Council Meeting on 5 December 1946 it was decided that this Committee should be discontinued, and that the responsibility for encouraging and authorizing publications should be vested in the Council. The question of publications especially devoted to the aims of the Association has been further considered in relation to the activities of the American 'Society for the Study of Evolution' and clarification of their programme has been received. This Society has undertaken the publication of a quarterly journal entitled *Evolution: International Journal of Organic Evolution*, devoted to papers having a bearing on the factors and processes of evolution, descriptive matter being restricted to the extent that it forms the basis for the evolutionary conclusions. The first double-number of this journal is now in press. The editor is Dr. Ernst Mayr, assisted by an international editorial board on which the Association is represented by Drs. Huxley and Turrill; members of the board retire in rotation, normally serving for three years, and the Society has intimated that it is most anxious to collaborate with the Association not only in regard to selections for the board of editors but in all other matters.

A practical expression of this desire is to be found in the fact that although the normal subscription for *Evolution* is to be $6.00 per annum, it will be available to members of the Association for $4.00 plus the cost of postage. Details of the procedure to be followed to obtain this generous reduction (equivalent to double the cost of membership of the Association !) will be announced when the manner of distribution and of payment have been worked out.

The Association's own plans for the publication of reviews and essays have been held in abeyance until practical experience of the field covered by *Evolution* has been obtained.

Education (convener Dr. T. G. Tutin). A joint discussion with the Linnean Society was held on 6 February 1947, the subject being the 'Teaching of Taxonomy'. The four principal speakers were Sir Clive Forster-Cooper, F.R.S., Prof. James Gray, F.R.S., Prof. A. R. Clapham and Dr. W. B. Turrill. A report of the discussion was published in *Nature*, Vol. **159**, p. 446. A full account of the discussion has been published in the *Proceedings of the Linnean Society* and copies distributed to members. A number of constructive suggestions were made during the debate and these have been referred to the Education Committee to prepare, if possible, detailed schemes for their implementation.

Taxonomic Principles and Comparative Systematics (convener Mr. A. H. G. Alston). When the resumption of work by these two committees was under consideration it became clear that their activities had previously overlapped considerably and became interlocked. Since this interlocking appeared unavoidable and, in fact, essential, it was decided to amalgamate the two. There are now in progress two main activities :—

(*a*) The listing and defining infraspecific categories that have been recognized in nature or are believed to be theoretically possible. During the pre-war meetings of the committee it became evident that progress was being held up because terms for various categories of variation (*i.e.* species and infraspecific units) were being used differently by different members. It was suggested that members might be able to agree as to what categories actually existed in nature, even though they denoted them by different terms. It was agreed that an attempt should be made to determine what actual infraspecific units could be recognized—including units peculiar to certain groups of organisms—as a preliminary to making an attempt to provide a terminology for them. This was intended to serve primarily as a basis for clarifying our own discussions and then, if a terminology could be devised to meet all our own difficulties, it might be published in the hope that it would meet with general acceptance by other systematists. Mr. Wilmott offered to file and collate all the precise definitions of infraspecific terms known to members but the information received by him before the outbreak of war was very scanty and little progress was made. Recently, however, there was discovered amongst the files of the late Mr. J. R. Norman, formerly convener of the committee, a number of lists of terms that had been sent to him. This information has now been sorted by Mr. Wilmott, added to his own, and prepared for collation and analysis. The original definitions of some of the terms have still to be found and it is unlikely that the list is exhaustive. Enough has been done, however, to provide a basis for a preliminary discussion of the lines on which the information can best be summarized to provide terminology to meet the requirements of modern systematics. If members who have not yet sent in any list have contributions to make, they should send them to Mr. Wilmott (preferably on 8 in. × 5 in. slips) for incorporation with those already received.

(*b*) The examination of ' the theoretical and historical bases in relation to, and the practical aims of, taxonomy, especially in relation to phylogeny '. In the past this subject has provoked lively discussions, during which it became evident that there was a great lack of unanimity amongst workers in different fields. A number of memoranda were prepared on various aspects of the problem but no generally agreed solution was reached. A joint discussion on the subject between the Linnean Society and the Association was held on 11 April 1940 (see *Proc. Linn. Soc.*, **152**, 1940, pp. 234–255), but no meeting of the Committee has been held since 1939. It is felt that it would now be useful for a selection of the memoranda prepared before the war to be published, so that biologists interested in the problem could see what measure of agreement was reached and on what points the members differed.

Research (convener Dr. W. B. Turrill). A few researches have been re-started since the end of the war, including Researches on *Silene*, Investigations of *Taraxacum* apomicts (on a small scale only) and Studies in *Fritillaria*. Several new researches have been commenced, for example on a possible ecotype in *Plantago coronopus*, investigation of *Agropyron* and research on *Rorippa*.

Publications during the year include :—

' Researches on *Silene*, No. XXVI.' *Kew Bull.*, 1946, No. 2.

' The ecotype concept,' *New Phytologist*, **45**, No. 1, 1946.

' A quantitative study of petal size and shape in *Saxifraga granulata* L. ', *J. Genetics*, 1947 (in Press).

Maps and Censuses (convener Dr. O. W. Richards). In 1939 the Systematics Association had two sub-committees—one on Maps (convener Mr. J. S. L. Gilmour) and one on Distributional Censuses (convener Capt. C. Diver). The work of the Maps Committee had not got very far when it was interrupted. The Distributional Censuses Committee had made considerable progress in collating the various schemes already in existence but found that for terrestrial and fresh-water species the basis for all of them was Watson's system of vice-counties. This system was itself found to be in need of clarification on a large number of points of detail. Mr. J. E. Dandy (Dept. Botany, Natural History Museum) who was co-operating with the committee as a representative of the Botanical Exchange Club, agreed to examine the definitions of the vice-counties. During 1939–46 Mr. Dandy did a great deal of research into this subject and his conclusions are nearly ready for publication. An essential fact is that county boundaries which largely determine those of the vice-counties have been subject to continuous change ever since Watson's time (1850–1860) and will go on changing. To get, therefore, a fixed set of units for recording distribution the best plan seems to be to determine what the boundaries were at the time Watson published his scheme and to publish maps with some explanation of the finer details. Mr. Dandy is preparing the necessary maps and text and it is possible that the Ray Society will publish it. When the units for recording distribution have been fixed, the sub-committee hope to prepare a pamphlet on the general subject of censuses. This might deal with the purpose of such studies, might remove various common misapprehensions as to their value, and would deal with the units for marine organisms which are not covered by the vice-county scheme. It might also list all the censuses hitherto published. Eventually it may be desirable to stimulate workers to start new censuses.

Treasurer's Report, 1946–47.

The balance was taken on 30 April 1947. The Ordinary Account stands at £136 19*s.* 1*d.* and the Special Fund at £233 13*s.* 8*d.* Outstanding debts amounted to £11 19*s.* 2*d.* The Council has agreed to the transfer of £52 from the Ordinary to the Special Account where it will earn interest.

The cost of running the Association for the year was £17 11*s.* 8*d.* These expenses are balanced by the subscriptions of Ordinary Members for the year.

Receipts from the sale of *The New Systematics* may be expected to continue, although on a diminishing scale. Income from the sale of ' Key Works for the Identification of the British Fauna and Flora ' is, however, almost at an end, as the stock, originally 500 copies, is now reduced to 40.

The number of Life and Founder Members is now 26, and Ordinary Membership stands at 80.

SYSTEMATICS ASSOCIATION

Balance Sheet for Year 1946–47

Ordinary Account

Receipts	£	s.	d.	*Expenditure*	£	s.	d.
Balance at Westminster Bank 30 March 1946 ...	82	5	1	Typing and Duplicating ...	9	11	3
Subscriptions of Ordinary Members (28 pd. 3 yrs. 2 pd. 2 yrs., 40 pd. 1 yr.)	32	7	6	Subscription to the Biological Council	2	2	0
Sale of ' Key Works ' by Messrs. Adlard & Son, (47 copies)	12	15	8	Secretaries' Expenses ...	2	3	3
Royalties from the sale of ' The New Systematics ' by the Clarendon Press (188 copies)	19	14	10	Balance at Westminster Bank	136	19	1
Sale of ' Key Works ' to members and others (3 @ 7*s.* 6*d.*, 10 @ 5*s.* ...	3	12	6				
	£150	15	7		£150	15	7

Outstanding:

	£	s.	d.
Treasurer's Expenses: (Payment to Housekeeper at Linnean Society)	2	0	0
Stationery, postage, etc.	1	15	2
Adlard & Son (cost of printing Rules) ...	8	4	0
	£11	19	2

Special Fund

	£	s.	d.
Balance in Post Office Savings Bank on 30 March 1946	183	19	1
Life Membership Subscriptions (9)	45	0	0
Interest	4	14	7
	£233	13	8

Balance in the Post Office Savings Bank on 30 April 1947 ... ... £233 13 8

E. B. BRITTON
(*Treasurer*).

Examined and found correct:

H. E HINTON,
28 May 1947.

THE LINNEAN SOCIETY OF LONDON,

BURLINGTON HOUSE, PICCADILLY, LONDON, W. 1.

SOME SPECIAL PUBLICATIONS.

A Catalogue of the Linnaean Herbarium, compiled and annotated by Spencer Savage, F.L.S. London, 1945. (Pp. xvi+226, frontisp., 8 plates and pull-out leaf). £3 net.

Synopses of the British Fauna:—

No. 1. *Opiliones*. By Theodore H. Savory, M.A., F.Z.S. (New Edition.) 2*s*. net.

No. 2. *Caprellidea*. By R. J. Harrison, B.A., A.L.S. 1*s*. 4*d*. net.

No. 3. *Gammaridae* (*Amphipoda*) ; *with Key to the Families of British Gammaridea*. By D. M. Reid, F.L.S., Department of Biology, Harrow School. 3*s*. 4*d*. net.

No. 4. *Freshwater Bivalves* (*Mollusca*),—(*Corbicula, Sphaerium, Dreissena*). By A. E. Ellis, M.A., F.L.S., Biology Department, Epsom College. 2*s*. 6*d*. net.

No. 5. *Freshwater Bivalves* (*Mollusca*).—*Unionacea*. By A. E. Ellis, M.A., F.L.S., Biology Department, Epsom College. 5*s*. net.

No. 6. *Lumbricidae* (*Annelidae*), *with a Key to the common species*. Dr. L. Cernosvitov† and Dr. A. C. Evans, Rothamsted Experimental Station. 2*s*. 6*d*. net.

No. 7. *Talitridae* (*Crustacea Amphipoda*). By D. M. Reid, F.L.S., Department of Biology, Harrow School. 2*s*. 6*d*. net.

Catalogue of the Printed Books and Pamphlets in the Library of the Linnean Society of London. New Edition, London, 1925. (Pp. 860.) 13*s*. 4*d*. net.

General Index to the first Twenty Volumes of the Journal (*Zoology*) . . . London, 1896. (Pp. 437.) 6*s*. 8*d*. net.

General Index to the first Twenty Volumes of the Journal (*Botany*) . . . London, 1888. (Pp. 428.) 6*s*. 8*d*. net.

The Darwin-Wallace Celebration held on Thursday, 1st July, 1908, by The Linnean Society of London. London, 1908. (Pp. 118.) 3*s*. 4*d*. net.

Catalogue of the Manuscripts in the Library of The Linnean Society of London.—Part 1. *The Smith Papers*. (*The Correspondence and Miscellaneous Papers of Sir James Edward Smith, M.D., F.R.S., first President of the Society*.) By Warren R. Dawson, F.R.S.E. London, 1934. (Pp. 114.) 13*s*. 4*d*. net.

[*Continued overleaf.*

SPECIAL PUBLICATIONS (*continued*).

Catalogue of the Manuscripts in the Library of The Linnean Society of London.—Part 2. *Caroli Linnaei Determinationes in hortum siccum Joachimi Burseri. The text of the manuscript in the Linnaean Collections*, edited by Spencer Savage, F.L.S. London, 1937. (Pp. 78.) 13*s.* 4*d.* net.

—— Part 3. *Synopsis of the Annotations by Linnaeus and contemporaries in his Library of Printed Books.* By Spencer Savage, F.L.S. London, 1940. (Pp. 20.) 6*s.* 8*d.* net.

—— Part 4. *Calendar of the Ellis Manuscripts. (The Correspondence and Miscellaneous Papers of John Ellis, F.R.S.)* By Spencer Savage, F.L.S., Hon. Memb. Sv. Linné-sallsk. (Pp. vi, 104.) London, 1948. 25*s.* net.

'A Prodromus of the British *Hieracia*.' By the late H. W. Pugsley, B.A., F.L.S., has been published as Vol. 54 of the Society's Journal, Botany, comprising pp. iv, 356, and 17 plates. Copies are available for purchase by non-members, £3.